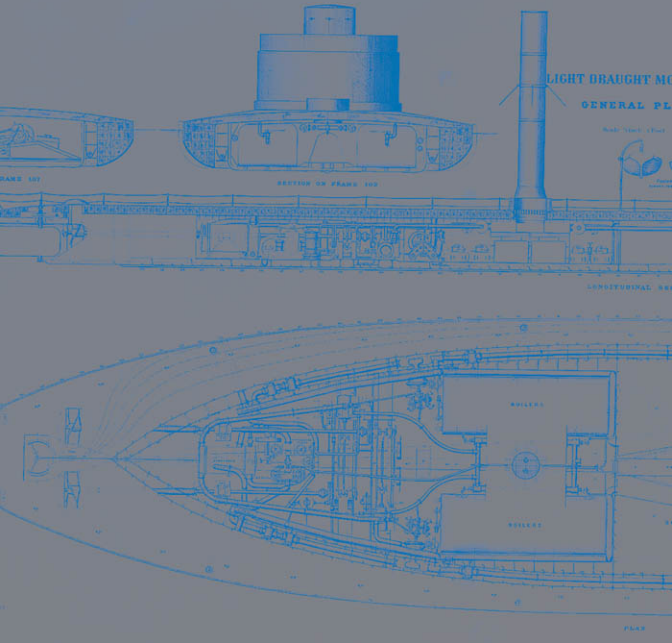
William H. Roberts

Civil War Ironclads

THE U.S. NAVY AND INDUSTRIAL MOBILIZATION



VISIT…

Civil War Ironclads

Johns Hopkins Studies
in the History of Technology

Merritt Roe Smith,
Series Editor

William H. Roberts

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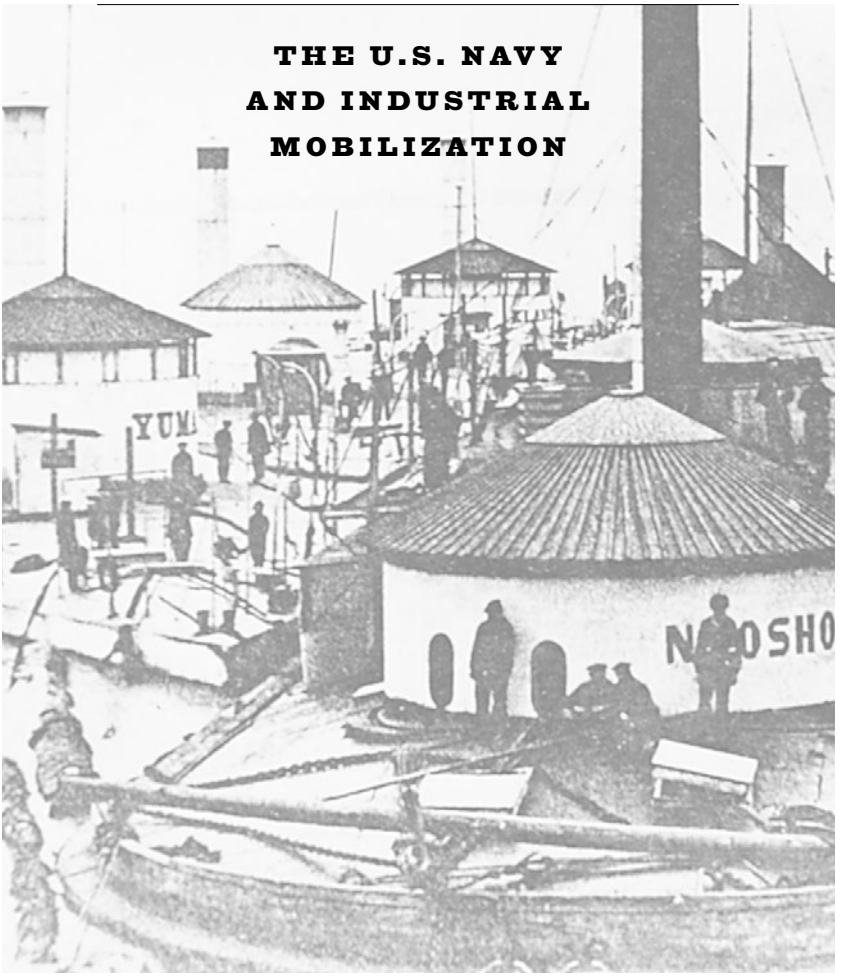

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Title page illustration: detail from photograph of monitors at Cairo, Illinois. Full photo and credit information are on page 183.

To Peg, who persevered,
to Judy, who wondered,
to Dad and Ing, who supported,
and to Mom, who didn't get to see

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Civil War Ironclads

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Introduction

For thousands of years, warships were built of wood and powered by human muscles and the wind. Gunpowder carved the first niche for chemical energy and machine-made materials, but successfully mounting and using cannon aboard ship still required vast amounts of timber and muscle power. In the mid nineteenth century, however, naval warfare changed dramatically. The Crimean War produced halting steps toward mechanized combat at sea, but not until the American Civil War did a navy conduct a campaign fought from start to finish by seagoing machines.

Those machines had to be designed and built, and Civil War navies grew as much from the economic and industrial resources of the combatants as from their political and strategic thinking. In the South, modest means led to modest programs. On the Union side, a relatively well developed industrial and financial apparatus allowed the creation not only of a blockading fleet of steam-powered wooden and iron vessels but also of a strategically offensive fleet of ironclads. This study explores the Union's industrial mobilization and the U.S. Navy's evolution of a flexible, effective system to manage a ship acquisition program of unprecedented size and technological complexity.

Although the Union's longest-running and most consistently pursued naval campaign was the blockade of the Confederacy, the massive federal ironclad program illustrates the broadly offensive orientation of Union Navy leaders and demonstrates that they, like Army leaders, intended to carry the war to the enemy. Rich in industry and skilled manpower, the North was far better equipped to wage technological warfare than the South, and Secretary of the Navy Gideon Welles intended to use Northern resources to the fullest.

The experimental nature of ironclad technology complicated matters. Political and public relations imperatives rather than superior technology drove the Navy's selection of the monitor type of ironclad (by 1862, "monitor" had become a generic term), but all ironclads were "high technology" for their day. The Navy's backlog of orders for steam engines and the Army's shortage of small arms suggest that merely getting manufacturers to build more copies of proven designs was difficult enough. Union shipbuilders, machine shops, and ironworks were completely unprepared for such a massive demand. The need to develop a new technology under conditions of tremendous urgency also imposed huge strains upon governmental and economic infrastructures, which were accustomed neither to large projects nor fast action.

High technology, while necessary, did not itself suffice to enable the Union to create its ironclad fleet. Ships were the tangible products of a system of ship acquisition, and the system existing in 1861 was itself the product of many years of peacetime evolution. Traditional Navy shipbuilding management methods, ample for building wooden ships in ones and twos, could scarcely handle the high-quantity production of technologically advanced ironclads. Recognizing this problem, the Navy turned to private contractors to build its ships and established a "project office" system, in which Secretary Welles appointed Rear Admiral Francis H. Gregory as general superintendent of ironclads and gave him broad authority to manage the ironclad program practically independently of the existing Navy administrative system. Gregory's office, under the de facto leadership of General Inspector of Ironclads Alban Crocker Stimers, provided desperately needed drive and direction during the critical months of 1862 and 1863.

Stimers's so-called monitor bureau also spearheaded the Navy's deliberate attempt to broaden the North's industrial base. The three ironclad vessels commenced in September 1861 were well within the nation's capabilities. After the Battle of Hampton Roads in March 1862, however, Union ironclad construction shifted into high gear. By the spring of 1863, the Navy had ordered more than fifty coastal and seagoing ironclads. Despite its imperative need and its undoubted economic and industrial might, the Union could neither build all the ironclads it wanted nor build all of them at once. Besides ironclads for coastal and oceanic service, the

Navy also had to provide armored and unarmored vessels for riverine service, unarmored vessels to blockade the Southern coast, and cruisers to chase Confederate commerce raiders. All these programs competed for the Navy's industrial, personnel, and financial resources, while the Navy as a whole competed with the Army for the nation's resources.

Urgency thus led the Navy increasingly to turn away from traditional shipbuilders. In 1862, it began a deliberate attempt to expand ironclad production by granting contracts for coastal ironclads to inland firms, and the monitors built in Cincinnati, Ohio, provide material for a case study and for comparison with seaboard builders. Shipbuilding materials and skilled labor were in short supply nationwide, however, and these twin scarcities fueled the inflation that bedeviled many poorly capitalized shipbuilding firms. Few of the initiatives to build more ironclads produced ships in time for them to fight.

By early 1863, the first fruits of the building program were available, and the Navy could begin to use armored ships against the enemy in some strength. The Navy chose Charleston, South Carolina, as the target of this first ironclad campaign, which became the naval counterpart of "On to Richmond!" Charleston's defenses precluded an attack with wooden ships, so ironclads, and more particularly Passaic-class monitors, were the centerpiece of the campaign.[1]

The Charleston campaign showed that just as ironclad acquisition entailed more than technology, ironclad warfare entailed more than armored ships. Under intense pressure, the general superintendent's organization had to learn to support a high-technology fleet while developing an effective way to incorporate the lessons of combat both in existing ships and in vessels under construction. The monitor bureau created a surprisingly modern support mechanism that included mobile repair teams, prefabricated alteration kits, and a stock of standard repair parts.

The Navy's ironclad program therefore comprised a system, made up of related parts connected by a network or structure. Navy leaders used more or less centralized controls to direct the system toward particular goals and optimize its performance—the goals being to build technically suitable ironclad vessels quickly and in quantity, and to support them once built. Far from being purely technical, the ironclad program relied on many nontechnical elements and was subject to many outside influ-

ences. The ironclad builders, like technological system builders a century later, discovered that their system's managerial aspects "loomed as large as [its] engineering ones."[2]

Systems management was not on John Ericsson's mind when the inventor presented his turreted ironclad design to the Navy's Ironclad Board in 1861. Ericsson, one of three key players in the U.S. Navy's Civil War ironclad program, had built the highly successful machinery for the Navy's first screw steamer in 1843. In 1844, however, he was unjustly associated with an ordnance explosion that killed the secretaries of state and of the Navy. His relationship with the Navy's technical agencies was at best one of mutual wariness, and he found no real enthusiasm for his monitor design until after the *Monitor* and the Confederate ironclad *Virginia* fought the Battle of Hampton Roads in March 1862.

Observing that battle was Assistant Secretary of the Navy Gustavus Vasa Fox, the second of the three key players. Fox, who almost instantly became the Navy Department's most ardent champion of the monitor design, drove the vast expansion of ironclad production. His refusal to acknowledge that "better is the enemy of good enough," however, made him the major reason why the Navy's program of industrial expansion was only partially successful. Fox's constant demand for design changes caused many of the delays that crippled the expansion program.

The third key player was Chief Engineer Alban Crocker Stimers, U.S. Navy, a talented and hard-working naval engineer. Stimers supervised the construction of the original *Monitor* and became a true believer in the type; his role in building the vessel and in her battle with the *Virginia* gained him Fox's confidence. As the general inspector of ironclads, Stimers became the de facto head of the project office nominally led by Gregory. Stimers oversaw the monitor mania of 1862–63 and pressed hard to extend the autonomy and responsibility of the general superintendent's office—in modern terms, to build the ironclad system incrementally.

Technological uncertainty complicated the Navy's mobilization. When the Civil War began, ironclads were high technology, and practice had outstripped theory in many areas. Engineering knowledge in such circumstances would normally advance through the mechanism a leading historian of aviation engineering has labeled "variation-selection."[3] Yet selecting from various models or approaches, a sequential process, takes

time, which in the context of the Civil War was simply not available. The Army and the Navy shared the problem of expanding industrial production; unlike the Army, the Navy had first to decide what it wanted to produce. For predominantly nontechnical reasons, the "selection" was made before the "variation" could be fully considered, and the Union program concentrated on monitors.

In this respect as in others, the American experience differed significantly from that of the naval powers of Europe. Europeans and Americans faced the same technological uncertainty, but European constructors saw little of the urgency that permeated the U.S. ironclad program. The more relaxed atmosphere led European ironclad building onto different paths.

The French ironclad program of 1858–60 frightened Great Britain and elicited a prompt response. Even under this French pressure, though, the British took an average of twenty-seven months to complete each of their first five ironclads, and as the initial scare evaporated, construction slowed. Between 1859 and 1863, the Royal Navy commenced twenty-four oceanic ironclads, of which fourteen were begun as ironclads and the other ten converted from partially built wooden hulls. In the same period, the U.S. Navy commenced more than fifty such vessels, all but one built from the keel up. The fourteen new-construction British ships averaged almost three and a half years to build, while their fifty American counterparts averaged just under two years.

Even during their initial building surge, then, European naval leaders had far more time than Fox and Stimers—time to plan and test, to refine and improve, and to institutionalize the new technology. The slower pace allowed naval constructors to develop and test more experimental designs before moving on to large-scale production. In addition, constructors could employ technically superior solutions (such as solid armor rather than laminated plates) even if they took longer to produce. Organizationally, European navies had time to integrate ironclads into their naval design and construction organizations. The U.S. Navy, with the nation in peril, sought quick results by going "outside the system."

Neither the broadened industrial base nor the advanced acquisition management system survived the return of peace. The Union Navy's mobilization required tremendous industrial effort and could not help but affect the manufacturing economy of the North. Its effect, however, was

neither permanent nor wholly beneficial—mobilization was more like a breaking wave than a rising tide. Like a wave, the mobilization crested, broke, and receded, leaving only detritus to mark its passage. Owing to capital starvation and a Navy philosophy that allowed design changes to flourish unchecked, the expansion shipyards failed to meet expectations during the war. When Navy contracts evaporated after the war, so did the western yards, and, soon thereafter, so did most of their eastern counterparts. Physical, technological, and economic factors combined after the war to reduce the U.S. demand for ships, and shipbuilders weakened by their wartime participation in the monitor program were unable to survive the lean times and make the transition to commercial shipbuilding in iron. Although the monitor program benefited a few, for most ironclad builders, it proved detrimental.

Similarly, the initial success of the wartime acquisition system was overtaken by very public and expensive failures. The qualities that had served Stimers well in building the General Inspectorate proved detrimental in running it, and Stimers's professional self-destruction through overwork, engineering misjudgment, and personal ambition discredited the embryonic project office system. Stimers's failure and a postwar reaction in Congress against wartime contracting excesses set the Navy back in its management of ship acquisition. The hard-learned lessons of the war years were forgotten or ignored for decades.

The Navy's regression illustrates "technological momentum," which a project as large as the ironclad program could not help but redirect.[4] Momentum equals mass times velocity, and velocity is a vector quantity; so technological momentum will be affected differently by failure than by success. Successful projects leave positive feelings and successor programs in their wakes. Unsuccessful programs intensify natural backlash with the stigma of failure. Although the reasons they gave varied, influential men saw the monitor program as a failure, and their aversion to the elements they perceived to be responsible meant that the project office system lay among the casualties of peace.

Most Civil War naval literature concentrates on naval operations, the technical details of ships, or the strategic and political aspects of the naval struggle. Far less has been written on the acquisition and logistics systems that provided the Navy with ships and kept them at sea, and practically nothing on the industrial effort born of the Union's urgent

need for ironclads. The present work is the first comprehensive study of one of the most ambitious programs in the history of naval shipbuilding.

The study follows roughly chronological order. The first section depicts the genesis of the monitor program in the tearing urgency of the "improvised war" of 1861 and 1862, compares prewar and early Civil War ship acquisition, describes how Alban C. Stimers became the "indispensable man" of monitor construction, and examines how the Navy's enthusiasm for monitors had by midsummer 1862 overtaxed the coastal shipyards and forced the expansion of shipbuilding to inland waters. The second section surveys the establishment of shipyards west of the Alleghenies in late 1862, explores the highly adverse impact of frequent changes of plan, and analyzes the effects of changes, delays, inflation, and labor shortages upon the monitor program to show how the Navy's relations with its shipbuilders aggravated the mounting delays. It then describes the interplay of systemic factors and character flaws that dethroned Stimers and impelled a reorganization of the "monitor project office" in 1864.

The final section looks at the reasons why the mature project office system of 1865 was abandoned so rapidly after the war. It tracks the vessels of the monitor program to their postwar deliveries and shows why the wartime expansion shipyards (and many established yards as well) withered as fast as they had grown. In conclusion, it shows that failure can redirect technological momentum as readily as success and demonstrates how the failure of the monitor program crippled Navy ship acquisition for a generation.

The obstacles the Navy encountered in its Civil War industrial expansion are cogently described in a comptroller general's report to the Congress of the United States:

> There is little doubt that [the contractor] and the Navy substantially underestimated the problems involved, including
> —starting a new facility,
> —obtaining an adequate work force,
> —designing ships 2,000 miles from the construction site by a completely new organization. . . .
>
> All of the above problems are reflected in the schedule delays, the cost overruns, and the numerous changes in management.[5]

Although the words precisely depict the Navy's experience in its Civil War industrial mobilization, the comptroller general wrote this report more than a century later to describe the shipbuilding programs of the early 1970s. Mobilization to support the acquisition of high-technology items in quantity has remained a challenging problem.

CHAPTER 1

"I Have Shouldered This Fleet"

Gustavus Fox and "Monitor Mania"

In 1859, France launched the world's first seagoing ironclad ship, the frigate *Gloire,* and in 1860, Britain countered with HMS *Warrior*. By the end of 1860, the two navies had a total of ten ironclads in hand, but the United States had little attention to spare for such developments. America's big event of 1860 was the presidential election, and America's focus was the crisis caused by Republican victory. As the crisis grew during the winter of 1860–61, President James Buchanan watched without acting against secession. Hoping to avoid confrontation, he forbade naval or military preparations that might alarm Southerners.

When Abraham Lincoln took office as president on March 4, 1861, his goals differed from those of his predecessor in one critical element: Buchanan had wanted to preserve the Union without war; Lincoln wanted to preserve the Union. Even within Lincoln's new administration, however, reasonable men differed as to the policies he should follow. Buchanan had done nothing to prepare the Navy for conflict, but Lincoln's avowed policy of conciliation and his urgent desire not to commit an overt act of war against the new Confederacy was almost as big a handicap. When war began in April, a combination of administrative inexperience, uncertainty, and the disloyalty and opportunism of some officers hobbled the Navy Department's ability to act. As an institution, the Navy had to work out these difficulties while conducting a naval expansion of a size never before attempted, using an administrative and legal framework designed for and attuned to the slow rhythms of the small peacetime establishment. Yet within six months after Fort Sumter, the

Navy had recognized a need for armored vessels, gained authority and appropriations to build them, obtained and evaluated proposals for them, and signed contracts to have them built. Urgency, first, last, and always, colored every decision the Navy Department made in the first two years of the war.

In 1861, the Union's war aim was to restore Southern political responsiveness without losing support in the North. Northern officials, exposed for years to the idea of a "slave power conspiracy," generally agreed that a minority of Southerners had hoodwinked the rest into leaving the Union, so the Union should follow a mild policy to win back the Southern majority. These men believed that economic isolation, combined with a short ground campaign to take the Confederate capital at Richmond, would cause Southern Unionists to rally to the old flag.

In this political climate, the aging General Winfield Scott formulated a plan to blockade the Confederate coast and advance along the Mississippi River. This strategy, known to its detractors as the "Anaconda Plan," aimed to encourage the growth of Southern Unionist sentiment by strangling the commerce upon which the South's economy depended. Such a blockade would also reduce the South's ability to export cotton to pay for military imports and disrupt Southern coastwise trade, especially in cotton and foodstuffs.[1]

Scott's plan called for the Navy to blockade the coast, but Southern hydrography and technological advances made the project much easier to assign than to accomplish. Hydrographically, many rivers, bays, and inlets penetrated the South's long, low-lying coast. Coastal irregularity and the limitations of visual surveillance meant that the Union would need many ships to cover the blockaded area, and shallow water meant that blockading vessels would need shallow draft to patrol close enough to shore to be effective. More important, the widespread use of steam propulsion meant that the blockade had to be based on steamers. Sailing ships and underpowered auxiliary steamers were not fast enough to enforce a blockade against steam-propelled merchant ships.

The prewar U.S. Navy was manifestly unequal to the task, both in numbers and in types of ships—on March 4, 1861, the Navy had forty-two commissioned vessels scattered from New York to Japan, with twenty-nine more laid up in Navy yards. The Union boasted only thirty serviceable steam warships, some with only one gun. Nevertheless, President

Lincoln proclaimed a blockade of Southern ports on April 19, 1861. At first a blockade that existed mostly on paper, it became effective as rapidly as the Navy could obtain ships to make it so. Despite the Union's initial lack of ships, Lincoln could be cautiously optimistic about a blockade, because the Southern transportation system was in many ways underdeveloped. If the North could interdict the coastal and riverine shipping so important to the Southern economy, the South would be thrown back upon its very limited railroad system. The seven Southern seaports with interstate rail connections became prime targets, since closing a few major ports would be easier and be more effective than blockading many lesser harbors.[2]

The task of implementing the blockade fell upon Secretary of the Navy Gideon Welles. Welles immediately began to buy and arm merchant steamers and to enlist men to supplement the ships and crews he had. Both actions had considerable historical precedent and could be begun without much discussion, but once they had been initiated, thought would be required as to what to do next. Welles took the first step on May 30, 1861, by instructing the chiefs of the Navy Department bureaus to consider how to supply the blockading squadrons, especially in the Gulf. The bureau chiefs met the same day to grapple with the problem.[3]

Quickly determining that specially adapted steamers would be needed, the board of bureau chiefs recommended that supply ships sail from the North to the Gulf and back by way of Key West, Florida, with a similar plan for the squadron on the Atlantic side. More recommendations followed over the next few days, but as early as June 1, the board's deliberations had broadened to include shipbuilding policy and "mail clad steam floating batter[ies]," evidently as a result of discussion of the blockade problem in general.[4]

Although this discussion went beyond the board's instructions, it was a logical outgrowth of the supply problem. The steam machinery that had revolutionized blockade tactics and naval construction had also revolutionized naval logistics. In the days of sail, blockaders could maintain their stations with occasional supplies of provisions and water, but steam vessels also needed coal and repairs. The bureau chiefs expected supply ships to distribute their cargoes at "the rendezvous of the Squadron," but underway replenishment was many years in the future—the "rendezvous" had to be a port, not a point in the open ocean.

Unfortunately for the Federals, the few Southern outposts remaining to them could not support a blockade. On the Gulf coast, the Union held Fort Pickens at Pensacola, Florida, but the Confederates had captured the Navy Yard and Fort Barrancas across the bay, so there were no repair facilities. Key West remained in Union hands, but it also lacked repair facilities. Between Key West and Hampton Roads, Virginia, Union ships had no supply base or port of refuge; for major repairs, ships had to go even farther north than Hampton Roads. Unless the Union could establish logistics facilities close to the theater of operations, a blockade would require too many ships to be practicable.

Secretary Welles recognized the broadening scope of the blockade support problem, but he also recognized that the bureau chiefs, who already had full-time jobs, were not the best men to address it. At the instigation of Professor Alexander D. Bache, then Superintendent of the U.S. Coast Survey, Welles called a conference and appointed Captain Samuel F. Du Pont as the senior member.[5] The conference (also called the Blockade Strategy Board and the Committee of Conference) convened on June 27, 1861, for what became three months' work.[6]

Welles told Du Pont that the Union had to capture at least two points on the Atlantic Coast and others on the Gulf of Mexico. Du Pont's instructions were to "condense all information in the archives of the Government" and to report any that would bear on the "contemplated movement" to seize bases for the blockade. The conference went well beyond that to produce *"mémoires"* with broader implications.[7] While a detailed discussion is beyond the scope of this book, the conference's reports greatly influenced Union strategy. On August 3, 1861, Welles told Du Pont that the "invasion and occupation of the seacoasts of the States in rebellion, as proposed by the Navy Department," had been "accepted by the Government." The War Department agreed to an expedition, and Welles appointed Du Pont to command its Navy component.[8] Scott's "Anaconda" initially became more than a constrictor because the Navy needed to support and tighten the blockade. The logistics of steam forced the constrictor to develop amphibious fangs, and once it had teeth, the Navy's commitment to the offensive use of naval power against the Confederacy's coasts never wavered.

Unlike the Union, which had to advance and occupy at least part of the Confederacy to gain its ends, the South could win simply by outlasting

the North. The Confederacy thus faced naval challenges in 1861 that were the opposite of the Union's—namely, to maintain its commerce and to protect its coast. The Confederates planned to meet these challenges by fortifying their coastal regions and by sending out privateers and raiders to attack Union commerce (thus diverting ships from the blockade), but Confederate Secretary of the Navy Stephen R. Mallory knew that the Confederacy would eventually have to deal directly with the Union blockade of its ports.

For all his troubles, Secretary Welles enjoyed major advantages over Secretary Mallory: the North had a functioning naval bureaucracy, a growing number of ships with an officer corps and a pool of mariners adequate to man them, and a large maritime and industrial base upon which to draw. In his efforts to circumvent Welles's blockade, Mallory had to start from scratch in every area, from administrative organization to biscuit bakeries and shipyards. Beyond the 247 U.S. Navy officers who "went south," he had a handful of seized revenue cutters and the resources of the partially destroyed Gosport (Norfolk, Virginia) Navy Yard. This profound maritime weakness made a symmetrical force-on-force strategy impractical. Lacking the resources to challenge the Union with wooden steamships, Mallory decided to place his faith in technology. Invulnerability, he wrote, could make up for unequal numbers, and he approved plans to convert wooden ships into ironclad vessels. Confederate workmen began the first conversions in mid 1861.[9]

The Confederacy's number one project, at least in terms of causing anxiety to Union officials, was the conversion of the scuttled steam frigate USS *Merrimack* into the ironclad CSS *Virginia*. Workmen at the Gosport Navy Yard started the project in July 1861, and officials in Washington received regular reports of their progress from spies and newspapers. The Federals were especially concerned about the *Virginia* project because besides breaking the blockade of Norfolk, the ironclad might bombard Fort Monroe or steam up the Potomac River to threaten the Union capital.[10]

By mid 1861, therefore, the Union clearly needed vessels to counter the Confederate ironclads, and several unsolicited proposals for armored ships had already been received.[11] On July 4, 1861, Welles advised the U.S. Congress of the problem and asked it to approve a board to investigate the issue. On August 3, 1861, Congress authorized a board of naval

officers to inquire into armored ships and appropriated $1,500,000 to build "one or more armored or iron or steel-clad steamships or floating steam batteries."[12]

With this legislation in hand, Welles lost no time. On August 7, 1861, the Navy advertised for proposals for "iron-clad steam vessels of war," of iron or of wood and iron combined, to draw from ten to sixteen feet of water. Shallower draft, the Navy stressed, would be preferable.[13] The next day, Welles appointed a board to examine the proposals he expected to receive. The "Ironclad Board" consisted of Commodores Joseph Smith and Hiram Paulding and Commander Charles H. Davis. The board did not include a naval constructor among its members, but Paulding, who was 63, had commanded the Washington Navy Yard from 1851 to 1855, and Smith, at 71, had been chief of the Bureau of Yards and Docks since 1846. Davis, the youngest, aged 54, had been the secretary of the just-adjourned Committee of Conference, leaving him well informed of the strategic challenges the new ironclads would face.

The Ironclad Board faced challenges of its own, since ironclad technology was in its infancy. The French and British had built successful ironclad ships, but ironclads on the European model took a long time to build and drew far too much water to be useful off the Southern coast. The Ironclad Board had to sift the proposals the Navy received to find a shallow-draft design that would be effective and could be built quickly.

The board received seventeen proposals of widely varying form, practicality, and degree of detail, ranging from William Norris's ninety-ton steam gunboat to Edward S. Renwick's 6,520-ton behemoth. The board promptly rejected some designs—it did not take a naval constructor to see flaws in William Kingsley's theory that a rubber covering would make shot bounce off his vessel. Some designs were too sketchy to evaluate. Others would be too time-consuming or expensive to build, and still others came from men who had no experience in turning their sketchbook fantasies into reality.[14] As the board deliberated, its members were constantly aware of the urgency and the high stakes involved.

The board recommended that Welles build three of the proposed vessels. One of the designs it accepted, which became the USS *Galena,* was proposed by Cornelius S. Bushnell. The *Galena* had a conventional hull and broadside battery, armored with interlocking strips of wrought iron. Even with a traditional sailing rig, the proposal was unconventional, and

the board required Bushnell to guarantee the ship's buoyancy and stability.[15] A second design, even less conventional, was John Ericsson's single-turreted, low-freeboard vessel. Ericsson's design had the shallowest draft and shortest estimated construction time, but against it were its extremely low freeboard, turret-mounted guns, and total reliance on steam power. Although some have faulted the board members for skepticism, two of the three designs they chose (Bushnell's and Ericsson's) were novel. The board took a flyer on Ericsson, and quick construction was the key factor in Welles's decision to build the *Monitor*.

Board members saw what the Union Navy needed immediately—"vessels invulnerable to shot, of light draught of water"—but other factors clearly influenced their deliberations.[16] Most important, they could see that the nation dared not stake everything on untried designs—if those designs failed, disaster would result. The board therefore took out insurance by choosing as its third vessel a fully rigged, high-freeboard ship with solid wrought-iron armor and a broadside battery, like those already built in Europe. The Philadelphia firm of Merrick & Sons based its design on successful European ironclads, and its proposal became the USS *New Ironsides*. Ericsson's novel, cheap, shallow-draft ship promised a big payoff, while Merrick's conservative design traded higher cost and longer construction time for lower technological risk.[17] Bushnell's design was a compromise; like many such, it had the disadvantages of both alternatives and the advantages of neither.

The board also worried about the ability of the chosen designs to fight in the open ocean. The Navy expected the Confederates to use *Virginia* in Hampton Roads, but beyond that immediate objective, their intentions seemed less clear. Steadily multiplying rumors had the Confederate ironclad ascending the Potomac River to attack Washington, while others feared she would instead put to sea to attack seaboard cities such as New York.[18] More thoughtful minds realized that she would float too deeply to reach Washington, but Union assessment of her seagoing capabilities was murky.[19] The board accordingly made another trade-off among seagoing qualities, draft, and technological risk. Again, Merrick & Sons' conservative high-freeboard design was the better-known quantity, while shallow draft favored the riskier Ericsson and Bushnell designs.

Welles had to balance the benefits of rapid construction, shallow draft, and low cost against the risk of technical failure. Although both Welles

and the Ironclad Board foresaw a long-term threat from Europe, the immediate threat from the Confederacy meant that the North desperately needed a combat-effective ironclad. The board's choices showed that its members understood that need.

In assessing the genesis of the Navy Department's ironclad program during the critical months of 1861, several elements must be considered. First, ironclads formed only one facet of the Navy's effort; although the stakes were very high, so were the stakes in other areas. Second, the ironclad program suffered more than any other from technological uncertainty. Third, the improvisation that sustained the creation of the blockading fleet in its early days could not be applied to ironclads intended for oceanic operations; the Navy could extemporize blockaders by putting a few guns on more or less suitable merchant ships, but a successful coastal or seagoing ironclad would have to be built from the keel up.

All the while, Welles was receiving constant criticism from public officials and private individuals alike. While he surely agreed in principle with the frustrated citizen who wrote, "*Everything* ought to be done *instantly* for our navy to get & remain ahead of the Rebels everywhere," the secretary understood the constraints under which the Navy operated.[20] Between them, Welles and Assistant Secretary of the Navy Gustavus Vasa Fox (Fig. 1) did an excellent job of ensuring that the most important projects received the highest priority, while neglecting nothing vital. Welles wrote later: "I was accused of not having a navy of formidable vessels. I had vessels for the purposes then wanted."[21] In addition to the blockading fleet, those vessels would include serviceable ironclads.

The prevailing theme of the Union ironclad program was urgency, but urgency compounded by technological uncertainty. Increasing production of a proven design would have been difficult enough, without the handicap of having to design, test, and build it simultaneously. In 1861, ironclad warships represented cutting-edge technology—technology that had advanced beyond science's ability to explain how it worked. To see how warship design progressed, it is helpful to look briefly at how engineers advance knowledge in the absence of sound theory, using the mechanism that a leading historian of aviation engineering calls "variation-selection."

Fig. 1.1. Gustavus Vasa Fox, assistant secretary of the Navy (1861–65). Naval Historical Center photograph NH-61175.

Engineers make progress through a process of variation and selective retention. The variations come from the need to go beyond the bounds of established knowledge to solve problems. When engineers create such variations, they may be able to calculate the limits within which their results will lie, but the range of results between those limits gives room for some designs to succeed and some to fail. Whether the design succeeds or fails, the variations yield new technology, which must be tested by experiment or experience. Unsound technology is discarded; sound technology is retained to expand the body of knowledge. The term "variation-selection" sums up the process.[22]

Two important caveats are needed. First, the variation-selection model concentrates on "normal design," the improvement of an accepted tradition or its application under new or more stringent conditions. With minimal "accepted tradition," 1860s ironclads verged on "radical design," in which "the problem is to design something that will function well

enough to warrant further development." Further, as originally formulated, variation-selection is an essentially internalist model of engineering development that pays little attention to external influences. A successful variation-selection process must account for nontechnical factors such as willingness to make long-term financial or industrial investments, wartime urgency, and the needs of the constituencies involved. Certainly, this was the case with ironclads. The Navy was constrained by money, industrial capacity, and time as well as strategy, geography, and technology. Ironclads competed for the Navy's resources, while the Navy competed for the nation's resources. Complicating matters was the intense pressure to produce effective ironclads as quickly as possible.

In theory, variation-selection should result in a sequential program: ships would be built and tested over time, with the test results being incorporated in follow-on ships.[23] Under wartime conditions, however, urgency overwhelmed theory. Given that urgency, one would expect the Navy to undertake a "parallel development" program, building and testing several competing variations simultaneously before choosing the most promising for large-scale production. In the beginning, the Ironclad Board initiated just such a parallel development program by picking three dissimilar designs to build and test simultaneously. Construction of these three vessels (the *Monitor, Galena,* and *New Ironsides*) began in September and October 1861. Up to the autumn of 1861, then, the urgency-modified variation-selection model well describes the actual events.

By mid 1862, however, the model and the facts had diverged. In April 1862, the Navy made a near-total commitment to Ericsson's *Monitor* design, and it would eventually order more than fifty coastal and seagoing ironclads based on it, compared to four of other basic designs. The reasons that the Union built an entire fleet to a single revolutionary pattern lie in the nontechnical aspects of the process.

The Navy originally accepted Ericsson's proposal primarily because his vessel could be built quickly.[24] His design showed a small, low-freeboard, shallow-draft vessel with bow and stern overhangs to protect anchor and rudder. Thick armor would protect the ship, but the need to limit draft, size, and construction time kept him from using too much of it. Low freeboard and turret-mounted guns reduced the extent and weight of the armor and presented a small target area, while the turret provided all-around fire and mechanical means to handle the guns. The

ship, later named *Monitor*, would be built by a partnership consisting of Ericsson and three prominent businessmen: John F. Winslow, Cornelius S. Bushnell, and John F. Griswold. Ericsson was to provide the engineering; the others provided the capital.[25]

More important than capital, Ericsson's partners commanded political influence. Winslow and Griswold were partners with Erastus Corning, a powerful member of Congress, in an iron works in Troy, New York. Both Winslow and Griswold were good friends of Secretary of State William H. Seward, who gave them a strong letter of introduction to President Lincoln, and Griswold later succeeded Corning in Congress.[26] Meanwhile, Bushnell commanded influence of his own. The Mystic, Connecticut, businessman was a good friend both of Welles and of James E. English, a member of the House naval committee, and his firm had the capital and facilities to build the *Galena*.[27]

The three first-generation Union ironclads were markedly different, and engineers continued to generate variations for follow-on ships while the first three were being built. Warship design, however, is an iterative series of compromises, and exaggerating one characteristic means that others must suffer. Ericsson, for example, emphasized shallow draft, small size, and a limited target area; to achieve those characteristics, he gave up freeboard, habitability, and room to operate and repair guns and machinery. He emphasized speedy construction and gave up thick solid armor because laminated armor, made of several thin plates, could be fabricated more quickly. The new ironclad technology had no accepted tradition, so Ericsson's design quickly acquired shallow-draft competitors that embodied different technological compromises.

Ericsson's most serious competitor was the "Bureau" design, so called because the Navy's Bureau of Construction, Equipment and Repairs developed it. Chief Constructor John Lenthall, head of the bureau, and Benjamin Franklin Isherwood, the engineer in chief of the Navy, benefited from the Ironclad Board's work to design a ship slightly larger than Ericsson's. This wooden-hulled variation would have carried solid 4 1/4-inch side armor and two turrets, each containing a single 11-inch gun; unlike the *Monitor*, it would have had twin screws.[28]

The Bureau design seemed sound enough to allow Welles to commit to ironclads in a big way. On December 2, 1861, the secretary asked Congress for $12 million for ironclads, an amount greater than the entire

Navy budget for 1860.[29] Early ironclad legislation gave the Navy wide discretion (the August 1861 law appropriated $1.5 million for ironclads and required only that "one or more" ships be built), and Welles's proposal, introduced as House Bill 153 on December 17, 1861, simply authorized "twenty iron-clad steam gunboats."[30] Although the legislation did not specify a particular type, the Navy made no secret of its intent to build "Bureau" ironclads, and the Navy Department published their specifications by December 20, 1861.[31] As far west as Ohio, the *Cincinnati Daily Commercial* observed that the Navy Department was "sending out specifications, inviting proposals . . . for the construction of iron clad steam batteries. The Government is very anxious that this class of war vessels should be immediately constructed."[32]

Welles's implicit proposal to build twenty ships to the Bureau design alarmed Ericsson and his partners. For one thing, there was bad blood between Ericsson and the Navy's shipbuilding and engineering bureaus. "With the bureaus he was no favorite," as Ericsson's very partisan biographer William Conant Church notes. Lenthall and Isherwood seem to have viewed Ericsson as a prima donna.[33] In turn, the inventor referred to Isherwood as a man "utterly devoid of constructive skill, not an engineer from the start," and called him "my persecutor for twenty years." Ericsson's record established him as a competent engineer rather than a flash in the pan, but he had had some notable failures (for example, his "caloric" hot-air engine) and his impatience with those who disagreed with him was equally well established. The "Bureau" ironclad, designed by Lenthall and Isherwood and equipped with turrets based upon those proposed by Captain Cowper Coles, RN, seemed to Ericsson to be an insult.[34]

More important, the Ericsson group wanted more contracts to build vessels like the *Monitor,* and the Bureau design would have reduced their prospects for follow-on work. To prevent this, the Ericsson group applied great pressure on behalf of the *Monitor* design. In the technical realm, Ericsson lucidly advanced his ideas for follow-on *Monitor*s in a late December letter to Welles. In the political arena, Corning fired the opening salvo when he told Welles that the Navy should not take "hasty and immature action" on the proposal to build twenty ironclads. "A few days delay may be far less important" than building overly expensive ships that would not produce the "very best result."[35] The story of the Er-

icsson group's machinations is more fully told elsewhere, but it is clear that consuming national urgency was colliding head-on with commercial interest.

Soon after Corning's letter, in early January 1862, Winslow visited the Navy Department. "At least the Navy Department will not authorize *more* than one or two boats on the Isherwood plan till ours is put in proof," he wrote Ericsson on January 6. If Ericsson's design succeeded, "I have a promise from the *very* highest source that we shall have all we want of the 20 to be built."[36]

Winslow based his early January optimism on his interview with Fox, who by 1862 had emerged as the de facto operational head of the Navy. Fox's energy, seagoing experience, and long-established friendships with Navy officers made him invaluable to Welles; Winslow called his influence controlling. His dynamism gained him President Lincoln's confidence, but the same dynamism hindered his commitment to long-term study, planning, and follow-through.[37] Fox was perpetually vulnerable to quickly developed enthusiasms.

The House had approved the "twenty ironclads" bill two days after its introduction. Arriving in the Senate on December 20, 1861, it went to Senator John P. Hale's Committee on Naval Affairs, where it remained for almost three weeks. The bill reappeared on January 8, 1862, two days after Winslow's interview with Fox. Hale tried to use the bill to embarrass Welles, but when he failed, the twenty ironclads disappeared again into committee rather than being voted up or down.[38] Hale's pique may have caused the recommittal, but events indicate that Fox's conversion did not adequately reassure Winslow's associates.

After nearly a month's inaction, on February 3, Welles wrote to Hale, citing the House's promptness and noting how important it was that there be as little delay as possible. The Navy needed a decision one way or the other. In drawing Hale's attention to this matter, "which I had anticipated would receive the early action of the Senate," Welles stressed the "extraordinary condition of the country."[39]

In response, on February 5, Hale asked Welles, "What is the plan on which the Department proposes to build [the twenty ironclads]?" Welles replied on February 7 that the Navy Department would not "confine itself exclusively to any particular plan yet offered; but proposes to avail itself of the experience which will be gained in the construction of those now

going forward, one of which will be soon tested in actual conflict." Welles mentioned Ericsson by name, and this clear acknowledgement that the Navy Department had forsaken the Bureau design broke the legislation free.[40]

The Senate approved the twenty ironclads on February 7, 1862, the same day that Welles replied to Hale. Ericsson's backers were clearly in control; as Bushnell wrote to Ericsson, "no plans, drawings, or anything of the kind have been made yet for the proposed twenty iron-clad vessels—in fact, I have it from the highest authority that everything depends upon the test of your battery, and that until after her trial nothing will be done."[41]

The Navy's advertisement for bids for the twenty ironclads appeared on February 20, 1862. On March 8, the *Virginia* sortied to attack Federal ships in Hampton Roads. Destroying the frigates *Cumberland* and *Congress,* she threw the North into panic. Even cabinet officers (most visibly Secretary of War Edwin M. Stanton) gave way to hysterical fear.[42] The *Monitor* arrived from New York late that day and fought the *Virginia* to a draw on March 9, 1862, and the North's fear was suddenly transformed into euphoria.[43] As Winslow had predicted, Ericsson's prestige soared.

Politically, Fox's euphoria was the most important. Intellectual conviction as to the *Monitor*'s merits was one thing, but as Fox watched the *Monitor-Virginia* fight from Fort Monroe, conviction gave way to adulation. Ericsson's ship had fought a battle, retrieved a naval disaster, and given the Navy a public relations triumph. Fox found the combination irresistible. Although Du Pont exaggerated when he wrote that Fox was "possessed" by Ericsson, there was an element of truth in the admiral's assertion that the *Monitor* had saved the assistant secretary from humiliation and disgrace. Under the circumstances, it was natural for Fox to overlook the *Monitor*'s faults.[44] The Battle of Hampton Roads made Fox a "monitor man," giving the monitors the "most potent countenance of the Navy Department." Fox wrote: "I have shouldered this fleet, and I doubt if any one can stand in the way provided we are successful." Less than a week after Hampton Roads (and ten days before bids for the twenty ironclads were to close), Ericsson received a verbal order for six "improved *Monitor*s."[45]

Welles also wanted some of the credit. Convinced from the first that the *Monitor* would succeed, he wrote, he had recommended the immedi-

ate construction of twenty ironclad steamers. He had seen that the country would suffer from the Senate's inaction, and by a personal appeal obtained immediate authorization of the ships.[46] He conveniently omitted the Navy Department's original intention to build the twenty ships to the Bureau design.

In this light, the Battle of Hampton Roads validated the deal between the Navy and the *Monitor* group. Besides delaying the Union's ironclad program for two to three vital months, the deal and the battle combined to foreclose further experimentation. A single inconclusive action established the design of the entire ironclad fleet, for reasons at least as much psychological and political as technical.

There was little effective counterpressure from the builders of the competing first-generation ironclads. Bushnell, builder of the *Galena,* was a member of the *Monitor* syndicate; from a purely financial standpoint, "it did not matter [to Bushnell] which ship succeeded, as long as one of them did." Merrick & Sons, then building the *New Ironsides,* proposed two improved *New Ironsides* designs but also offered to build one of Ericsson's "improved *Monitor*s."[47] Unlike Ericsson, who had a deep emotional as well as financial investment in his design, Merrick seems to have been indifferent to what it built as long as it got contracts.

Charles Cramp, an associate of Merrick & Sons, was far from indifferent. He branded the Navy's focus the "MONITOR craze," alleging that a "combination, or 'ring,'" had been formed, "with head-quarters in New York, to prevent the construction of any type of iron-clad vessel except monitors."[48] The Navy's 1862 contracts support his characterization of a New York "ring." Twenty-three pre-1863 monitors went to private contractors; of those, fifteen were built in the New York City area or by subcontractors working for Ericsson's group. Of the first fourteen, twelve were built in the New York City area or by New York City prime contractors.[49]

Welles later noted that after the Battle of Hampton Roads, Winslow was "very importunate and persistent" in claiming that the Ericsson group "should have the exclusive privilege of building all that class of vessels {for the Government}." Even if that were allowable, Welles told Winslow, Ericsson and his associates did not have the capacity to build all the vessels the Navy would want. "He said they would sublet and insisted they were entitled to this privilege as much as if they {had} procured a patent. The claim was preposterous, and I refused to recognize it,

but they were allowed {given} contracts for several vessels."[50] It would be autumn 1862 before the monitor ring's grip slackened.

While the monitor design dominated the Union's coastal ironclad program, the less numerous seagoing ironclads showed less homogeneity. Without going into detail, the seagoing category shows more variation, and seagoing ironclads thus offer a counterexample to the monitor case and show the more divergent paths that coastal ironclads might have taken. For coastal vessels, however, the variation-selection process ended prematurely. The monitor ring used its congressional allies and the impression the original *Monitor* made on Fox to gain an irresistible advantage.

Would-be builders responded to the Navy's advertisement for the twenty ironclads in two ways—monitor look-alikes and ships based on the "Bureau" design. The Navy board formed to evaluate the proposals recommended combining the two designs, merging *Monitor*'s iron hull and low freeboard with the Bureau design's thick iron plates, twin turrets, and twin screws. Feeling that the ten "improved *Monitor*s" Welles had ordered would meet the Navy's immediate need, they urged him to issue plans of the combined design upon which any shipbuilder could bid.[51] The recommendation fell on deaf ears.

The contracts let in spring 1862 show the extent to which monitors dominated the ironclad program. The ten "improved *Monitor*s" of the Passaic class formed the largest group.[52] Monitor variants with twin turrets included the *Onondaga* (built by George Quintard of New York) and the four wooden-hulled Navy yard–built ships of the Miantonomoh class.[53] The *Merrimack*'s sister ship, the *Roanoke,* would be converted into a vessel that looked like a triple-turreted monitor with higher freeboard, and even the *Keokuk,* which had two stationary gun towers instead of revolving turrets, resembled the monitor design.[54]

Once the Navy had chosen a design, it moved quickly to procure it in quantity. After awarding six Passaics to Ericsson the week after Hampton Roads, the Navy issued contracts for the remaining four within a few weeks. By summer, all of the ships authorized by the twenty ironclads bill had been placed. Welles continued to request and Congress continued to authorize more money for ironclads, but the Passaics marked the beginning of the Navy's preparations to use ironclads offensively.[55]

CHAPTER 2

Forging the Fleet

General Inspector Alban C. Stimers and the Passaic Project

The navy's enthusiasm for ironclads led to a construction program that dwarfed any previous shipbuilding effort. Whatever the truth of the claim that the *Monitor* had included at least forty "patentable contrivances," no one could doubt the novelty of the enterprise.[1] The Navy soon discovered that its prewar apparatus for building ships could not cope with the twin challenges of wartime urgency and revolutionary technology.

The sailing Navy had built its ships almost exclusively in Navy yards, where the Navy Department completely controlled the process. Ships were usually built by ones and twos, to designs prepared or approved by the Bureau of Construction, Equipment and Repairs. Even when different yards received the same plans and specifications, no one expected that their products would be identical—the vagaries of wood, a heterogeneous natural material, ensured uniqueness even in the absence of the natural human tendency to "improve" a design.[2]

Ship acquisition in the 1830s and 1840s involved long building times for small numbers of ships, government control of the process from design to finished product, and responsiveness to input from operators—the line officers who would use the ships. These factors encouraged the accretion of design changes. It was as true then as now that most changes to ships involve adding something—more of these, another of that, something the designer forgot, something else the prospective commanding officer saw "on my last ship"—and even when individual changes have little impact, their aggregate effect can be serious.

The Navy's ship acquisition process received a thorough shake-up in the 1850s with the introduction of steam propulsion. Navy yards lacked facilities and personnel to design and build steam engines, so the Navy turned to private contractors for its propulsion plants. The frigate *Merrimack,* a wooden steam vessel of the 1854 "Young America" program, shows how the Navy evolved a system to maximize the impact of the only element that contractors understood: money. First, contractors would receive progress payments (best considered as advances against the final contract price) at certain construction milestones. This would encourage timely fulfillment of the contract as well as relieve the contractor of some of the financial burden of building the machinery. Then, the contract included performance guarantees for the finished product. The Navy would "reserve" (i.e., withhold) final payment until the machinery performed successfully at sea.

Like earlier wooden ships, the six Young America frigates differed slightly from each other. The new technology accentuated the differences because the six power plants were built by five different contractors—for practical purposes, each combination of hull and power plant was unique. The Young America frigates, with sound if not outstanding power plants, showed the effectiveness of the new system of performance guarantees. The Navy learned a lesson: although it could not control civilian contractors the way it could control its own shipyards, "recalcitrant contractors best understood the power of the purse." It continued to refine the guarantee system in its 1857 and 1858 contracts for sloops of war.[3]

The Navy had internalized this lesson by the time ironclad construction began. In the absence of any in-house ability to build ironclads, the Navy had to depend upon contractors, and the contracts for the three first-generation ironclads incorporated the elements of the successful 1854 frigate and 1857 and 1858 sloop programs. They were what would now be called firm fixed price contracts, in which the contractor agreed to build a specified vessel for a specified price. During construction, the Navy would make progress payments to the contractor, withholding (reserving) 25 percent until the ship had been tested at sea. By contract, the government had ninety days to make these tests. If the ship did not meet specifications, the Navy could hold the ship as collateral until it recov-

ered the money it had advanced. The government would then return the ship to the contractor.[4]

Defects in the 1850s acquisition system quickly showed themselves once the war began. The reservation system presupposed that the government would be able to test the ship in a timely manner; easy enough in peacetime but not always possible under wartime pressures. The Navy's inability to complete testing prevented it from punishing Bushnell & Co. for faulty armor design in the first-generation ironclad *Galena*.[5] Similarly, the Navy's need for an ironclad to protect Hampton Roads prevented timely completion of the *New Ironsides*'s speed trials. Like Bushnell, Merrick & Sons avoided penalties because a system developed in peacetime could not protect the government from technical failures on the part of its wartime contractors.

The 1850s system failed in other ways. One was that the issue of changes to the contracts quickly arose. *New Ironsides*'s contract bound the contractor to supply "omissions in the specifications in regards to fixtures or fitments," and included a provision that permitted "slight modifications agreed upon by the contracting parties as the vessel progresses." The contract did not, however, provide any mechanism for negotiating such changes.[6] In the 1850s system, the contractor had built only the machinery, which was unlikely to change much between contract and delivery; most changes affected the hull and fittings of the ship, built by the Navy yard. Since the Navy yard did as it was told by the bureaus, changes were invisible—they might cause delays, but there were no repercussions outside the Navy. The lack of a mechanism for processing contract changes is understandable: none had evolved because none had been needed.

Yet changes were inevitable, especially when dealing with new technologies. During construction of the *New Ironsides,* major changes included the substitution of 11-inch guns on novel iron carriages for the original 8-inch guns on traditional wooden carriages, an increase in the crew from under two hundred to over four hundred men, and the addition of armored bulkheads, armored gunport shutters, and an armored pilot house. Someone had to pay for this additional work. In the end, the Navy and the contractor compromised: Merrick & Sons absorbed the items that the Navy deemed to be omissions (such as the port shutters

and pilot house), and the Navy paid for the items it considered to be changes.

The 1850s system also overemphasized financial matters. During the construction of the first-generation ironclads, Rear Admiral Joseph Smith of the Bureau of Yards and Docks frequently stressed the fiscal aspect of the contracts; he wanted to get the government's money's worth, and withholding funds was practically the only leverage he had.[7] The Navy's experience with the first-generation ironclads (as well as with other early wartime shipbuilding and conversion efforts) left an injurious but not entirely unjustified impression in the Navy Department. Contractors complained that their contracts were less profitable than anticipated. Navy officials gave some credence to the contractors' plaints, but mounting delays and increasing friction made them feel that most contractors were more interested in money than in fulfilling the terms of their contracts. Perceiving that many contractors were no more scrupulous than they were forced to be, the Navy adopted a wary, almost suspicious attitude, increased its inspection force, and mandated strict enforcement of contract provisions.[8] The effect over time reinforced the lesson that withholding funds was the government's chief weapon and inculcated the idea that many of the contractors' protests were merely ploys to increase their profits.

This brings to light another major problem with the 1850s contracting system: its inability to deal with changing economic conditions. Firm fixed price contracts served adequately in times of stable prices, but by mid 1862, the Union's economy had begun to falter. Wages and prices were rising, inflation had begun to show itself, and the Treasury Department could not pay the Navy's warrants promptly. It was, as Ericsson's biographer William Conant Church points out, "hazardous business to estimate upon government work."[9] Contrary to the Navy's perception of profiteering, contractors' margins were beginning to shrink as shipbuilders faced delays from their suppliers and poured more of their capital into their projects. The Navy reacted to contractors' slowness by withholding payments, but the economic climate made this counterproductive.

These problems would become acute in 1863-64, but the 1850s acquisition system had already begun to change in 1861. Even before the Navy started to build ironclads in quantity, it was clear that the old system took

too long to react. The prewar system had been highly centralized, knit together by a web of letters through which the Navy Department's bureaus had the final say in technical questions. This had been adequate when ships were being built slowly by ones and twos, but it broke down when ships were being built and converted in haste and by the dozens. Secretary of the Navy Gideon Welles solved the problem by decentralizing.

The Navy made its first move in this direction in New York, where, in July 1861, Welles recalled Captain Francis Hoyt Gregory (Fig. 2.1) from retirement and appointed him to supervise the construction of gunboats.[10] When the ironclad program began in October 1861, Gregory had little to do with it; all three first-generation ships were supervised by Rear Admiral Smith. One may presume, however, that Gregory knew of the progress of the *Monitor*, and knew also of the Navy's representative, Chief Engineer Alban Crocker Stimers (Fig. 2.2).

Stimers was born in Southfield, New York, on June 5, 1827. After starting in the Navy as third assistant engineer in 1849, he rose rapidly and was promoted chief engineer in July 1858.[11] He served as chief engineer of the *Merrimack* on her last cruise and decommissioned her when she returned to Norfolk in February 1860. When the Civil War began, Stimers was a member of the board that examined engineer candidates. On November 5, 1861, he was assigned to supervise the construction of the *Monitor* for the government. This duty brought him into close association with John Ericsson, in whom he gained great confidence, and gave him intimate knowledge of "Ericsson's battery." Accompanying the *Monitor* on her voyage to Hampton Roads in March 1862, Stimers distinguished himself by almost single-handedly saving the ship from foundering.[12]

During the Battle of Hampton Roads, Stimers operated the *Monitor*'s turret, then took command of the gunnery division when the executive officer left the turret to relieve the injured commanding officer. During the last part of the battle, Stimers, an engineer, was the only officer in the turret, occupying an operational command position quite extraordinary for one who was not a line officer.[13] He was one of only two officers mentioned by name in Fox's eyewitness reports of the battle, and Fox wrote afterward to Stimers: "I notice with pleasure that you are on hand this morning. . . . You must stay by the vessel and I rely greatly upon your skill and judgment." Such praise from so high an official was heady stuff for a staff officer one of whose line messmates described him as "smart

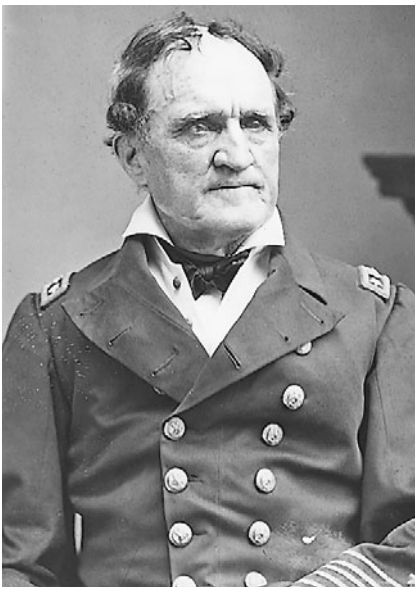


Fig. 2.1. Rear Admiral Francis Hoyt Gregory, general superintendent of ironclads (1862–66). Library of Congress photograph B8172-1812.

Fig. 2.2. Chief Engineer Alban Crocker Stimers, general inspector of ironclads (1862–64). Naval Historical Center photograph NH-44389.

but coarse—and like all of his kind [engineers] overbearing and disagreeable."[14]

Stimers "stayed by" the *Monitor* for several weeks after the battle, using his spare time to develop improvements to the ship's design. In late March, Fox asked Flag Officer Louis M. Goldsborough to send Stimers to Washington to serve on the board reviewing ironclad proposals. Goldsborough's reply shows how high Stimers's stock was: "I *cannot* spare Stimers. . . . I know how much he is wanted in Washington, but I know too that he is still more wanted here. He is a trump of the very first water." Stimers himself wanted at first to stay, hoping to help destroy the "formidable monster," but as it became clearer that the *Virginia* would not come out, he found it more important that he was "daily losing the opportunity of influencing the designs of the new Ericsson Batteries." He returned to New York in mid to late April 1862.[15]

In New York, Stimers found Ericsson's plans "so superior to anything I had expected" that he shelved his own.[16] He reported upon his arrival to Admiral Gregory, who on May 7, 1862, was designated general superintendent of ironclads, with responsibility for all those being built under contract along the East Coast.[17] Soon afterward, the Navy Department assigned Stimers to be general inspector of ironclads, responsible for the monitors and for Charles W. Whitney's experimental *Keokuk*. Gregory advised Stimers of his appointment on May 23, 1862, laying down his duties in very broad terms.[18] Gregory knew that Stimers had the confidence of the Navy Department and the ear of Assistant Secretary Fox; as the admiral later described it, "There came an order stating, very laconically, that Mr. Stimers would have charge of those vessels building on the Ericsson plan, and he took the charge." Stimers characterized their roles as follows: Gregory's job was "governing largely the personnel of the officers who had to do with the construction; I as general inspector governing wholly the construction itself."[19]

West of the Alleghenies, a similar decentralization was taking place. As the Navy expanded its riverine role, Welles ordered Captain Joseph B. Hull to St. Louis, Missouri, to supervise the Navy's shipbuilding efforts on western waters. Hull took charge of the gunboats under construction at Mound City, Illinois; Cincinnati; and Pittsburgh, Pennsylvania, but the western supervisory office never reached the level of influence that the New York office would attain.[20]

When Stimers assumed his new duties in May 1862, most of his work involved building ships of the Passaic class, designed by Ericsson as "improved *Monitor*s." The Passaics were twenty-eight feet longer and three and a half feet broader than the original *Monitor*, and they displaced 1,875 tons compared to the *Monitor*'s 987 tons. They also incorporated other improvements: the pilot house would be moved to the top of the turret for better visibility and less interference with the guns; the turret itself would carry two 15-inch guns behind eleven inches of armor instead of two 11-inch guns and eight inches of armor; they would be faster and more seaworthy.[21] The ten ships of this class would be the first fruits of the legislation for which Welles had waited so long.

Welles wanted those twenty ironclads for offensive action against the Confederacy. The Navy built its first-generation ironclads explicitly in response to the Confederate Navy's challenge; their origin and purpose were primarily defensive. Its second-generation ships went far beyond the need to counter the limited number of Confederate armored vessels. Welles openly declared his ambitious intentions before the bill became law, telling Senator John P. Hale, "The end proposed for the gunboat class is to reduce all the fortified seaports of the enemy and open their harbors to the union armies."[22]

Ericsson expressly considered action within range of shore batteries when he designed the original *Monitor*, but he considered it to be incidental to the vessel's primary mission; he clearly optimized his design to fight other ships. His philosophy involved placing the largest available weapons behind the heaviest practicable armor, with the avowed purpose of winning a ship-to-ship action with a few crushing blows. At the short ranges then in vogue for naval battles, reducing the rate of fire in return for the greater impact of a heavier projectile seemed like a good trade-off.[23] In the euphoria following the Battle of Hampton Roads, no one stopped to consider whether it would be a good trade-off against land-based adversaries.

Ericsson had begun to think about the Passaic design before the *Monitor* was completed, since he mentioned many of the improvements he would incorporate in his December letter to Welles. He began to make drawings as soon as the vessels were verbally agreed upon, but he worked closely with Fox and Stimers while he did so. The ships' characteristics remained under discussion into early April 1862, when Fox re-

ported that Ericsson was in Washington to consult "with our people and Chief Engineer Stimers of the 'Monitor.' Modifications and improvements have been agreed upon by all parties which render the new vessels very superior to the 'Monitor.' "[24] Clearly, the Navy and Ericsson did their best to incorporate the lessons of Hampton Roads in the follow-on ships; unfortunately, that relatively brief and indecisive action provided few lessons in areas that would emerge as vital. "The experience gained from the *Monitor* is so small that it is almost like beginning *de novo,*" the *Passaic*'s captain, Percival Drayton, later wrote Rear Admiral Samuel Du Pont.[25]

The concentration of the Fox-Ericsson-Stimers triumvirate on improving the basic *Monitor* design shows that the Navy perceived the most important issues to be technical. The *Monitor* was too slow, her pilot house was poorly placed, her ventilation was defective, and her guns could not penetrate the *Virginia*'s armor—these problems and a host of others required immediate attention. From a system viewpoint, the Navy perceived that the biggest problem was technological and accordingly placed its greatest emphasis on improving the monitor design.

An important result of Ericsson's vastly increased prestige was the Navy's insistence that other contractors use Ericsson's drawings instead of developing their own from general plans and specifications.[26] The underlying reason may simply have been enthusiasm on Fox's part, but the move would give the Navy the benefits of a production run of identical units—increased output and decreased delivery time. The procedure contained advantages and disadvantages for both "lead" and "follow" shipyards. To the detriment of the lead yards, Ericsson complained, other contractors "worked from our matured plans, made castings from our patterns and duplicated at the several forges our wrought iron work." Because the follow yards avoided expenses the lead yards had to incur, they could offer suppliers higher prices, thus gaining preference, and hire away the Ericsson group's best workmen.[27]

The follow yards had complaints of their own. From mid 1862 on, all shipyards were operating in a suppliers' market for materials that became more intense as the war continued. Until they received Ericsson's drawings, they could not place orders for the materials they needed. Although, as Ericsson's biographer stresses, "the drawing representing the part of the machine requiring the most work appeared first and the others followed in their order," any significant lag meant markedly in-

creased delay for the follow yards. If follow yards did offer higher prices to suppliers, those prices may merely have compensated for the disadvantage of being late into the market. Harrison Loring, of Boston's City Point Works, complained that the first contractors to order had a decided advantage in obtaining materials.[28] Because Ericsson was the designer, Ericsson's group always had that advantage.

In addition, there was a certain element of uneasiness in being forced to use someone else's plans. Ericsson's biographer observes that each of Ericsson's drawings went to separate shops or departments, "and no one knew what the completed structure was like until the several parts were assembled." That was all very well in the group's own establishments, but the follow yards had nothing beyond Ericsson's assurance that each part would indeed fit "in the others like hand to glove" and that the structure would work as designed. If the parts did not fit, the follow yard would have to pay for whatever wastage and reworking was required. Ericsson's vast self-confidence and intolerance of criticism could not have diminished other shipbuilders' concerns.[29]

Despite the increased size of the Passaics relative to the *Monitor*, Ericsson agreed to build four of them in four months and two more in five months. Secor & Co., another New York firm, offered to build one in four months for $400,000, the same price Ericsson was asking, while Harrison Loring was offered a contract for two vessels at $400,000 each, one to be completed in four months and one in five months.[30] Loring balked, attempting to alter the contract terms by eliminating the deadlines, but the Navy held firm. Loring next offered to build one ship in five months for $400,000. The Navy declined, observing that "as time is the most important object, it would not be just to the public service to allow you to select the longest time at the same price."[31] Loring had apparently overplayed his hand. On April 29, Welles offered contracts for one vessel apiece to Loring and his Boston competitor Nelson Curtis, of the Atlantic Works, with options balancing the price and the deadline (see Table 1). Loring chose the 4 1/2-month, $393,000 option on May 5, 1862, and Curtis accepted a vessel on May 11 at the five-month price, $386,000. Curtis's was the last to be commenced of the nine Passaic-class vessels intended for the eastern theater.[32]

Ericsson and his three partners had contracted to build six new monitors, but they themselves controlled no shipyards or machine shops. Ac-

Table 1

Price/Delivery Options for Passaic-Class Monitors

Time in months, from May 1, 1862	*Price offered*
4	$400,000
4 ½	$393,000
5	$386,000
5 ½	$370,000
6	$350,000
6 ½	$300,000

SOURCES: Secretary of the Navy Gideon Welles to Nelson Curtis, April 29, 1862, National Archives and Records Administration, Record Group 45, entry M209, 68: 141.

cordingly, they subcontracted all six vessels. Ericsson assigned three of them (the *Passaic, Catskill*, and *Montauk*) to his "first team," the firms that had built the original *Monitor:* Thomas F. Rowland's Continental Iron Works for the hulls and Cornelius Delamater's Delamater Iron Works for the machinery.[33] For his other three Passaics, Ericsson had to go farther afield.

Ericsson subcontracted two of the hulls (the *Sangamon* and *Lehigh*) to Reaney, Son & Archbold of Chester, Pennsylvania, and hired the well-established Philadelphia machinery firm of I. P. Morris & Towne to build their engines. He assigned the sixth monitor to the Wilmington, Delaware, firm of Harlan & Hollingsworth.

Ericsson's subcontractors were predominantly machinery or iron-working firms rather than traditional shipbuilders. Several reasons may be adduced. First, traditional shipbuilders were unlikely to be financially capable of taking on so large a contract. Wooden shipbuilding did not require much investment. The workers who built wooden ships generally owned their own tools, so shipyard capital requirements were small, and they were further reduced by the practice of subcontracting. In Philadelphia in 1860, the capital that fourteen shipbuilding firms reported to the

Census averaged about $23,800, and each on the average employed about 20 workers; as late as 1880, a facility to build wooden ships could be opened for less than $20,000. Iron ships required more capital investment; in 1880, a small yard to build iron ships could cost $60,000, and a moderate to large yard would cost from $200,000 to $1 million.[34]

Another reason may be that working extensively and almost exclusively in iron appealed more to those who already made their living in the metal trades. As one author phrased it, builders of wooden ships, "could easily imagine workers in their yards building an iron *ship,* . . . But could they as easily have imagined their men building a *boiler?*"[35] Still another is that shipbuilding in wood had also been markedly stimulated by the needs of the war. This study concentrates on ironclads, but most of the Navy's blockaders were unarmored wooden ships; although many existing ships were purchased, many were built from scratch.

Ericsson's choice of Harlan & Hollingsworth was perhaps the easiest to make. As Stimers noted, that firm was the most experienced shipyard in the country at building iron ships, although "experience" was relative. During the period 1855-61, Harlan & Hollingsworth averaged 4,019 gross tons of iron shipping per year, but much of their business still lay in building railroad cars. Although the company built ships as large as 2,250 gross tons, most were much smaller. Fifty-three hulls made up the 28,133 tons built during the 1855–61 period; subtracting the ten largest, the other forty-three averaged less than 310 gross tons apiece.[36] Harlan & Hollingsworth was also among the best-capitalized of Ericsson's subcontractors, carrying an "A No. 1" credit rating.[37]

The other Delaware River subcontractors, Reaney, Son & Archbold, were "machinists & iron boat builders." As a partner in Reaney, Neafie & Co. in the 1850s, Thomas Reaney had built six iron ships totaling 1,174 gross tons before leaving in 1859 to start his own firm. Reaney, Son & Archbold had built two iron hulls totaling 1,220 tons before tackling the monitors. The firm had less capital as well as less experience than Harlan & Hollingsworth; in 1862, it was reported to be worth $25,000 to $30,000.[38]

Ericsson's New York subcontractors also had experience with building in iron. Before building the engines for the *Monitor,* Delamater had built some small iron vessels in the 1840s and the 862-ton *Matanzas* in 1860. Rowland of the Continental Works had been a member of the firm of

Samuel Sneden & Co., which had built three iron hulls totaling 1,174 tons between 1859 and 1861. Sneden's firm failed badly in January 1861, and Rowland settled its affairs, apparently starting the Continental Works from its financial ashes.[39] Besides building the *Monitor,* Rowland had contracted to install the gun-port lids of the ironclad *Galena;* he found it to be a frustrating and expensive experience.[40]

For the remaining four Passaics, the Navy likewise turned to machine shops and ironworks rather than to builders of wooden ships. Of the two Boston firms, Harrison Loring and Curtis had each built iron ships, but Loring's four biggest, built in 1860 and 1862, were of composite wood and iron construction. Curtis had built only two iron vessels, both in 1861, totaling less than 400 tons.[41]

The last two vessels went to builders without experience in building iron ships. Charles A. Secor & Co. included the brothers Charles A., James F., and Zeno Secor; their father, Francis Secor, participated until his death in 1864. Before the Civil War, they operated as shipwrights, specializing in spars, as ship chandlers, and as builders of sectional dry docks. The brothers lost heavily in railroad speculation during the Panic of 1857 and struggled for the next few years. Despite James Secor's later assertion that they had always been shipbuilders and that they had "made large profits and succeeded in accumulating fortunes," their credit in the late 1850s was "impaired," and the 1860 census found Charles Secor and his family in a boarding house.

Prosperity returned with the war, and when the opportunity arose in 1862, the Secors began to build monitors. They gave up a small shipyard in New York and contracted with Joseph Colwell, son of a wealthy foundry owner of the same name, to establish a new shipyard and machine shop in Jersey City. They subcontracted the work on the *Weehawken* and *Camanche* to Colwell, who probably benefited from his father's capital and expertise but does not appear to have had any more shipbuilding experience than the Secors themselves.[42]

Although Ericsson and the other contractors had optimistically agreed to build the monitors in four or five months, most of the contractors had either to expand their ironworks or, like the Secors, to establish them from scratch, leaving absolutely no slack in the schedule. Part of Stimers's new job was to hold the contractors to their commitments, but to meet those commitments they had to order material immediately, and to

do that, they needed information: drawings, materials lists, specifications. Trying to supervise the building of six monitors while producing detail drawings for the entire class, Ericsson was, despite his talents, overburdened.

Stimers later asserted that Fox expected him to pick up the burden by designing ships himself. When he arrived in May, however, he could not do so. First, he quickly found his hands full as general inspector. Moreover, as he observed retrospectively: "Captain Ericsson had some feeling on the subject. He did not like that any other than himself should design monitors."[43] Yet clearly someone had to design monitors. Not only were detailed plans needed for the Passaics, but the Navy wanted at least two more classes of monitors.

When Secretary Welles asked Congress in March 1862 for more money for ironclads, he also laid out how it would be spent. Besides the Passaics and the riverine fleet, the Navy would build monitors "for harbor defence and to operate upon the Atlantic coast and in the Gulf of Mexico, which shall be as far as possible invulnerable, each armed with 15 inch guns." To counter the threat from the British and French, he proposed "to attempt an ocean steamer possessed of the same sailing and armoured properties, armed with guns of 20 inches calibre." Unofficially, Fox told a correspondent: "Government will build as many iron clad vessels in the next year as the country can produce."[44]

Ericsson had already begun designing "ocean steamers," seagoing monitors over twice the size of the Passaics, and had provided their specifications to the Navy by late May 1862. In late June, Welles gave Ericsson permission to build two such vessels, one with a single turret and the other with two turrets, and Ericsson provided the plans within ten days.[45] These ships, which would become the *Dictator* and the *Puritan*, were the inventor's pets and he lavished effort upon them. Even with his remarkable capacity for work, however, Ericsson was nearing his limit.

Simultaneously, the growing number of monitors steadily increased Stimers's inspection duties. Prewar practice had included assigning inspectors to contractors' establishments, but urgency and cutting-edge technology impelled the Navy to expand the existing model. Stimers suddenly had to provide continuous in-depth inspection of a large number of technically advanced vessels, which in turn required him to create a large corps of inspectors overnight. The general inspector built his or-

ganization from two sources: naval engineers detailed to the Inspectorate of Ironclads and civilians with more or less engineering training and experience who were hired to serve in the same capacity.[46] These resident inspectors lived near the ships they supervised and visited them at least daily to ensure that the contractors did not deviate from the specifications and that they used only good materials and workmanship.

In addition to certifying and forwarding the contractors' bills for progress payments, the inspectors reported every week or every two weeks to Stimers, advising him of the progress of their assigned vessels. Stimers consolidated the reports and sent them to Gregory, who in turn sent them to the Navy Department. Each ship also had an assistant inspector of machinery, who reported through one of Stimers's direct subordinates.[47] Stimers frequently visited shipyards up and down the eastern seaboard, keeping an eye on both the contractors and the local inspectors.

The creation of the Inspectorate of Ironclads marked a major accretion of power to Stimers's nascent project office. One reason was the inspector's authority to reject a contractor's workmanship or materials. Rejection could hinge on an inspector's interpretation, so Stimers's authority to direct the local inspectors gave him significant influence over contractors, for whom rejection meant delay and increased expense.[48] A second reason was that then, as now, knowledge means power. Stimers's local inspectors addressed their correspondence and reports to him, giving him first access to new information, and when he forwarded those reports, he could add his own comments and interpretations.

In the summer of 1862, the Passaic-class vessels were Stimers's biggest headache, and as the summer advanced, the pressure to complete them increased. The Navy Department was eager to take the offensive, and proposals to attack Wilmington, North Carolina, or Charleston, South Carolina, were in the air.[49] Naval firepower from wooden ships had taken Hatteras Inlet, North Carolina, and Port Royal, South Carolina, but wooden ships could not resist the sort of defensive artillery that guarded Charleston. To engage strong fortifications, the Navy needed ironclads. An action in mid May 1862 complicated Navy planning, however: the *Monitor* and the *Galena* attacked Confederate earthworks at Drewry's Bluff on the James River. The Confederates scarcely harmed the *Monitor*, but the *Galena* was riddled ("We demonstrated that she is not shot-

proof," her commanding officer, John Rodgers, wrote dryly). Neither ship did much damage to the Confederates in return.[50] Like the Battle of Hampton Roads, the standoff suggested that the defensively excellent monitor design might not be correspondingly potent offensively. To attack forts successfully, a number of ironclads would be needed.

Since Confederate fire had knocked the *Galena* out of the picture, those ironclads would be the *Monitor*, the *New Ironside*s, and Passaic-class ships. The first four Passaics were to be finished by July 31, 1862. By the end of August, all nine East Coast ships should have been completed, but the *Passaic* herself, the most advanced, was not even launched until August 30. By early August, Fox knew that the ships were far behind schedule; he forecast that the first could not be completed before October 1.[51] To speed up the ships, the assistant secretary applied ever-increasing pressure.

The contractors tried their best, but labor and materials shortages, startup and expansion delays, and inexperience had begun to bite. Responding to Fox's question about the feasibility of night or Sunday work, Ericsson wrote that his partners were already working extended hours, "taking as much night work out of our men as they can bear during this warm season." Unfortunately, he noted, the shipyards could not work two shifts: "Such is the pressure produced by the Government work that we cannot fill up our day gangs much less work the double system."[52] In early September, Fox told Stimers to add a carrot to the stick of penalties for late delivery, writing: "Give us two monitors and the Ironsides, and we will make Jeff Davis unhappy . . . Every effort should be used to hurry up two or three of these vessels for Charleston. Spare no expense." On September 15, he told Stimers, "If money will hurry the boats we will give it"; on September 25, he urged "every exertion possible, at any expense" to complete the ships.[53] The Navy Department wanted five monitors and the *Keokuk* in Hampton Roads on November 15; Welles himself told Gregory to have the monitors completed by November. By early October, all the contractors were working days, nights, and Sundays.[54]

By this time, however, changes to work in progress had become a problem. Then as now, changes during construction resulted from the natural desire to make each vessel as good as she could be. Yet each change involved a trade-off, in that it disrupted the efficient construction of the ship. At some point, the design had to be frozen if the ship were to

be finished. With vessels as novel as the monitors, designed and built in great haste, omissions were bound to occur and improvements were certain to suggest themselves. The Navy's rudimentary mechanism for dealing with construction changes broke down under the stress.

The contracts for the Passaic class included provision for changes, in unsophisticated language similar to that applied to the first-generation ironclads. Improvements "suggested by either party, and agreed upon, shall be adopted as the work progresses. All the modifications recommended and adopted" by the contractors would be warranted "to prove successful improvements, with any other improvements the parties to this contract may agree upon." A later clause reiterated that improvements suggested by the contractor would be guaranteed to work.[55]

While this language seemed to protect the government's interests, it failed to address important issues. The most obvious question was who would pay for modifications agreed upon by the government and the contractor. The case of the *New Ironsides*, in which the contractors were paid additional money "by bill of extras allowed by agreement," shows what was apparently intended, but that contract was not finally settled until November 1862, long after the Passaic-class contracts were entered into. For the seagoing monitors, "Ericsson was obliged to proceed under a general promise from the proper authorities that he should be compensated for his extra work." Welles assured him in April 1862 of the Navy Department's "interest and disposition to act in a liberal spirit towards you" with regard to changes on the Passaics.[56]

A more vexing question, and one that grew in importance, was that of pricing the modifications. The least sophisticated pricing model would cover the labor and material cost of doing new or revised work. This conformed to then-current pricing practices in the closely related machine tool industry, in which calculations included labor, materials, and subcontracting but ignored overhead, power, and depreciation.[57] A more comprehensive but little more sophisticated model would include the labor cost of ripping out the old work and the labor and material involved in removing and replacing items that were in the way (interferences). The most complex model would include indirect costs: not only the labor, power, and depreciation, but also the increased cost of doing the original work because of the delay and disruption incident to the new work. This model would also involve extension of the contract's deadline

so that the contractor would not be penalized for late delivery. At least at first, the government paid only for the new work and did not formally extend the end date.

Another issue that would assume great importance was the question of changes on which the government and the contractor did not agree. How would the system react to what in modern terms is a "unilateral" change? It was apparently understood that the government could compel the contractor—although contractors occasionally questioned Stimers's personal authority to order a particular modification, no contractor seems to have questioned the government's right to direct a unilateral change. The extent to which the government would then be liable for incidental claims (beyond the direct cost of the change itself) was unclear.

Perhaps the most disruptive change in the Passaics involved increasing the size and power of their ordnance. The *Monitor*'s 11-inch guns did some damage to the *Virginia,* but Fox wanted decisive results; 11-inch guns, he opined, were entirely inadequate against armored vessels. Seeing an 15-inch Army Rodman gun at Fort Monroe shortly after the *Monitor-Virginia* battle, he decided that the Navy must also have 15-inch guns. He directed Captain John A. Dahlgren, the Navy's premier ordnance expert and then commandant of the Washington Navy Yard, to design them.[58] Fox's move to deal with this issue again showed the Navy's perception that the monitor program's biggest hurdles were technological.

Dahlgren undertook the new gun, but reluctantly; he disliked following in Thomas Rodman's footsteps, and the project's accelerated timetable meant that he could not subject the weapon to the rigorous testing that was his trademark. He did not put his heart into the project; instead, he carefully laid the groundwork to dissociate himself from the design if it failed. Technical problems bedeviled the 15-inch gun, stemming from its new-to-the-Navy technology and its accelerated development, and production started very slowly. The first piece, slated for testing at the Washington Navy Yard, had not arrived by the end of September 1862; two others were then on their way to New York.[59] By that time, Ericsson was to have completed six monitors, carrying twelve of the guns.

For Ericsson, the change in caliber was critical. He had designed the Passaics' gunports for 11-inch Dahlgren smoothbores (or perhaps for the projected 13-inch Dahlgren, which did not appear until 1864). Although he received copies of the plans for the 15-inch when Dahlgren drew them

in April, Ericsson failed to redesign the gunports. When the time came to place the guns in the turrets, the muzzles would not fit through the ports (Fig. 2.3). A disadvantage of concurrent production of multiple identical units is that if something is wrong with one, the same thing is wrong with the rest. At the intersection of two technologically risky development programs, the Passaics were being built to carry guns of untested design, which had not yet been manufactured, and which they would in any case be unable to fire.

Other changes were smaller but equally vexatious. Percival Drayton, a highly respected naval officer, was ordered in late September to the *Passaic* as her prospective commanding officer. He immediately began to find deficiencies that Ericsson, no sailor for all his marine engineering experience, had overlooked. Besides the gunport problem, Drayton noted that but for his input, "we should have had no compass or any means of being towed. . . . [and] there would have been no possible

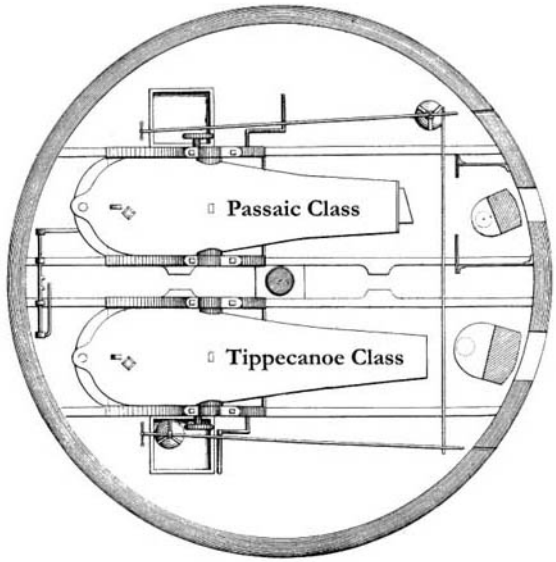


Fig. 2.3. Monitor turret showing 15-inch guns, with Passaic-class mounting on left, Tippecanoe-class mounting on right. Note the smoke box, shortened barrel, and muzzle ring required for firing the Passaic class's gun through the small gun port. U.S. Navy *Ordnance Regulations*, 1866, facing p. 108.

means of clearing the anchor." Ericsson, he wrote, "ignores every single thing but impenetrability, and that only in the turret."[60]

"All the reports you may have seen in the papers about the trials having been quite successful are mere interested lies, written for glorification of civilians and injury of the Navy," Drayton wrote Du Pont after several unsuccessful experiments. Better pleased with the *Passaic* once had Ericsson incorporated his own suggestions, however, Drayton believed that "when the Navy get fairly hold of [the monitors], we will suggest many improvements, beyond mere engineers and mechanics."[61]

For his part, Ericsson complained of the engineering ignorance of seagoing officers. Calling Drayton "only a seaman," he declared that Drayton "evidently does not understand the question [of *Passaic*'s speed] which is purely one of engineering." Attacking the tactical opinions of another monitor captain, Ericsson noted that naval officers were "now handling not ships but floating fighting machines and that however eminent their seamanship, they cannot afford to disregard the advice of the engineer." Inveighing against "useless articles and contrivances which are absolutely dangerous and in the way," Ericsson noted: "Much useless weight was put into the Passaic against my remonstrance to please her Commander."[62]

Both points of view had elements of validity. Stimers, an engineer with seagoing experience, summed up the impact on the ships when he wrote that the myriad details needed for a seagoing vessel "must in nearly all cases be designed and often the term invented is more correct." This added significantly to the time required to finish the ships, but once one was completed, he opined, the others would follow rapidly.[63]

Stimers's prediction appears to have been borne out. The class leader, the *Passaic*, was commissioned November 25, 1862, the problems with her 15-inch gun having been at least partially solved.[64] Two ships followed in December 1862, two in January 1863, and three more in February 1863. The Navy Department kept up the pressure, but the general inspector could not concentrate solely on expediting the Passaics. In the summer of 1862, Stimers had added another class of vessels, the "harbor and river monitors," to his growing responsibilities.

CHAPTER 3

The Navy Looks West

The "harbor and river monitors" took their name from Secretary of the Navy Gideon Welles's letter of March 1862 advising the Navy Department's intent to build monitors "for harbor defence and to operate upon the Atlantic coast and in the Gulf of Mexico," but the design for which the Navy contracted in August 1862 underwent drastic modifications that dramatically slowed the ships' construction and raised their cost. The harbor and river monitors engendered a shipbuilding expansion program of unprecedented magnitude and complexity, a program unequaled until the twentieth century. They also captured the difficulty of managing simultaneous expansion and technological development programs. With shipyards drowning in changes, the harbor and river monitors' contracted six months' building time extended to over three years in the expansion yards and averaged twenty-one months even in more experienced yards.

The Passaics were hardly under way when the Navy began planning the new class of monitors. Fox expected that Ericsson would design them, but the inventor was already overloaded with building six Passaics under his personal supervision, developing numerous changes to that design, and designing the *Dictator* and the *Puritan*.[1] Ericsson could not do justice to his two big pets, to the Passaics, and to the harbor and river monitors all at once.

Stimers's answer was to establish an office in New York, near Ericsson's own, where he placed a junior engineer and some draftsmen. Ericsson would produce a general plan and Stimers's draftsmen would fill in the details and submit each drawing to Ericsson for approval before it was issued. For the harbor and river class, Ericsson "drew up a general plan and submitted a general description," and Stimers consulted with Ericsson and Fox to develop the specifications, including "the changes

upon which we all agreed."[2] The new procedure marked another incremental expansion of Stimers's role in the ironclad program.

Stimers discussed many of the changes with Fox. The assistant secretary emphasized speed, writing that he blamed himself for not insisting that the Passaics be capable of nine knots. Ericsson had told Fox in April 1862 that he could design a monitor that would do twelve knots. Fox took this statement as the basis for the harbor and river monitors, and his correspondence sometimes refers to them as "fast monitors."[3] With Ericsson's general plan in hand, the Navy advertised for the ships on August 14, 1862. Fox's desire to build monitors west of the Alleghenies had crystallized; "every shop capable of doing the work, shall have one, both here and on the western waters," he wrote.[4]

Stimers's draftsmen were to develop working plans for the class based on Ericsson's general plan, but the Navy advertised for the ships before they had time to do so. Would-be builders had little beyond the general plan and specifications to examine, and many sent representatives to Washington or New York to ferret out enough information to be able to bid. James F. Secor wrote directly to Welles to request particulars, especially of "the difference between those referred to & the Monitors building here in New York." Charles A. Secor was told to consult directly with Ericsson, but when he visited Lenthall and Fox, he saw at least three other builders' representatives. A week in New York and an informal conference with Lenthall and Fox (informal enough that Fox sat on the arm of his chair with his feet on the seat) left another firm's agent with little information.[5]

Under these circumstances, the contractors had to take the Navy's advertisement at face value. It explicitly related the new vessels to the Passaics, requesting bids for vessels "similar to those building in New York, having a single revolving turret." Builders thus expected a vessel very like the Passaic class, and their conversations with Stimers, Lenthall, Ericsson, and Fox reinforced this idea. In addition, the preprinted contract gave the new ships' dimensions and stated that they were to be "upon the general plan of vessels now building." Although the new ships would be longer than the Passaics (235 feet versus 200), they would have the same 46-foot beam and 12 1/2-foot depth (Fig. 3.1).[6]

The specifications shown to the bidders and the information upon which they based their offers were much closer to the Passaics than to

what later emerged. At least three builders claimed that the precontract information that they were given did not match what was eventually furnished.[7] A court-ordered report supports that assertion, and another report by a board of naval officers explicitly agrees that there were three sets of specifications: the original specifications, closely resembling the Passaic class, upon which the contractors based their bids; the modified specifications furnished to successful bidders in October 1862; and the revised specifications formally issued in May 1863.[8] Despite this growth, the modifications do not appear to have been a deliberate attempt to cheat contractors.

The Navy wanted answers from eastern bidders by August 21 and from western bidders by August 28, so would-be monitor builders had to scramble to prepare their bids. The haste did not materially affect the bidding—even if the contractors had had months to work up their bids, the information they needed did not yet exist.

The fifteen firms that bid for what became the Tippecanoe class included several that were already building monitors (Table 2).[9] Harrison Loring's City Point Works was building the *Nahant,* and his hometown competitor Curtis was building the *Nantucket.* Harlan & Hollingsworth was building the *Patapsco* under Ericsson's subcontract, and the Secors had the *Weehawken* and the *Camanche.* All were Passaic-class ships.

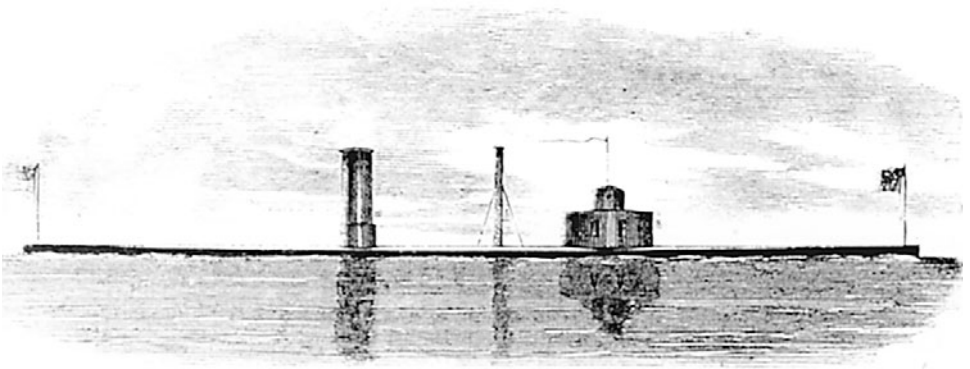


Fig. 3.1 The Tippecanoe-class monitor *Manayunk,* from an engraving in *Harper's Weekly* (1866). Naval Historical Center photograph NH 2902.

Table 2

Responses to the Navy Department Advertisement of August 16, 1862, for Iron Vessels for River and Harbor Defense

Firm	*Location*	*Number of Ships*	*Price (dollars)*	*Time (months)*
Harlan & Hollingsworth	Wilmington, Del.	1	525,000	6
Jas. Harrison	St. Louis, Mo.	2	675,000 each	9 and 11
Thomas Stack	New York	1	650,000	
Secor & Co.	New York	2	481,000 each	4 ½ and 5 ½
Geifse & McCoy	Wellsville, Ohio	1	670,000	9
Geifse & McCoy	Wellsville, Ohio	2	622,500 each	9 and 12
Miles Greenwood	Cincinnati	2	485,000 each	5 and 6 ⅔
Geo. C. Bester	Peoria	1	500,000	6
Snowdon & Mason	Pittsburgh	1 or more	472,500 each	6
Atlantic Works	Boston	1	640,000	7
Harrison Loring	Boston	2	490,000	6
			480,000	7
Pennsylvania Iron Wks	Chester, Pa.	1	595,000	7
Wilcox & Whiting	Kane's Point, N.J.	3	540,000	6
	"opp. Phila"		540,000	8
			520,000	10
William Perine	New York	1	480,000	5
Niles Works /	Cincinnati	2	450,000	5
Alexander Swift			450,000	6
S. S. Ashcroft	Cincinnati	1	457,000	7

SOURCE: National Archives and Records Administration, Record Group 19, entry 186.

Ericsson's own group did not bid on the new harbor and river class. Two reasons may be adduced. First, most group members had plenty of work. Cornelius Delamater's Delamater Iron Works, for example, was building the machinery for the Passaic-class vessels *Passaic, Catskill,* and *Montauk,* and both the hull and the machinery for Ericsson's pet

Dictator. Thomas F. Rowland's Continental Iron Works was building the hulls for the *Passaic*, *Catskill*, and *Montauk*, and the hull of the *Puritan*, as well as the hull of the double-turret monitor *Onondaga* under subcontract for George W. Quintard. Second, the political pressure from other builders and their allies had become intolerable. "Your associates have nearly five millions worth of work, and the public whom we serve expect other work to be scattered," Fox wrote Ericsson.[10]

Seven firms from west of the Alleghenies were among those who sought that work. The Navy had good reasons to cast its net so far from the shipbuilding centers of the East Coast. As Fox indicated, there was a political need to spread the wealth of government contracting. Also, many officials worried about the loyalty of the areas along the Ohio and Mississippi River valleys; increased prosperity, it was thought, would yield increased loyalty. Most important, East Coast shipyards and engine manufacturing firms were stretched to the breaking point with new construction and repairs; to get the ironclads it wanted, the Navy would have to broaden its industrial base.

Agitation for government contracts surfaced early in the West. In November 1861, the Cincinnati Chamber of Commerce memorialized Congress stressing the city's advantages for war work: central location, good transportation, natural resources, ample power, and skilled labor. The *Cincinnati Daily Commercial* reviewed the memorial at length, adding its own reasons why the government should not favor the East. Manufacturers such as Miles Greenwood had produced arms "on State and corporation orders," the *Commercial* reported, and no point in the Mississippi Valley could compare with Cincinnati in its potential arms output. "Here are the establishments, with the machinery and workmen and material all rusting for want of the employment which would, in its results, conserve the safety and restore the dignity of the nation." Greenwood himself wrote to Secretary of the Treasury Salmon P. Chase, a former governor of Ohio, to ask Chase's support for an armory in Cincinnati, offering to "take hold of this matter in the right way" if the government would advance the money.[11]

In January 1862, the *Commercial* deplored a stoppage of Army work, reporting that Mayor George Hatch of Cincinnati had visited Washington to impress upon President Lincoln, Secretary of War Stanton, and Chase "the importance of continuing the employment of persons here." The of-

ficials assured the mayor that contracts would not be curtailed.[12] The economic issue appeared to tie into the issue of loyalty to the Union. An analysis of Republican economic policies addresses several sources of sectional disagreement, but the tensions most significant to the western ironclad program were caused by the differences between Upper and Lower Northwest. New Englanders settled most of the Upper Northwest (Wisconsin, Minnesota, Michigan, and northern Illinois and Indiana) and the region displayed strong New England sympathies. The Lower Northwest, comprising the portions of Ohio, Indiana, Illinois, and Iowa that lay in the Ohio and Missouri River valleys, was aligned toward the South rather than to the East. This orientation led both to quarrels over national policy and to frequent threats to secede, threats that were taken seriously by many Republicans.[13]

The role of the Ohio and Mississippi Rivers as commercial arteries enhanced this perceived Southern orientation, which extended at least as far east as Pittsburgh. In September 1861, John Snowdon, a Brownsville, Pennsylvania, engine builder, had, "Gone by the board owing to Southern paper coming back unpaid." In the 1850s, Cincinnati's Niles Works had depended upon Southern orders: "Their principal bus[iness] is with the South—castings boilers &c also for rolling mills & pig iron machinery." In April 1862, Niles Works were reported to be "hard up," with business "v[er]y slack for some time past on a/c [account] of the southern trade being entirely stopped & have a g[oo]d deal shut up South." Many firms were in similar straits, helping to make opening the Mississippi to trade a federal objective.[14]

Careful analysis shows that the perceived biological, social, and economic ties that supposedly bound Cincinnati to the South had eroded by 1861: the city was western, not Southern. The railroad connections of the 1850s had swung Cincinnati's economic compass from south to east, and the value of the city's commerce was rapidly being overtaken by its manufactures. The economic panic that gripped Cincinnati in 1861 reflected the same difficulty experienced by other Northern cities rather than a Cincinnati-specific loss of Southern markets.[15] Yet this is retrospective, the view from a few decades' distance, rather than contemporary perception. Early in the Civil War, the threat of disunion and of a "Northwest Confederacy" was taken quite seriously.[16] Anything that might reduce the threat by favorably influencing the populace was worth trying.

The most important reason for extending monitor production to western yards, however, was the condition of the shipyards and machine shops on the eastern seaboard. All were jammed, crowded to capacity and beyond. Any establishment that might possibly build a ship's engine was under contract to do so. In July 1862, Fox noted that marine engine manufacturing limited the number of ironclads the Navy could build, writing that ships were begun "as fast as contracts for engines shall be made." August brought the complaint, "The engine builders are where we fail, every establishment that can make an engine is at work but skilled labor is high, scarce and independent." In December, "there is no work shop in the country capable of making steam machinery or iron plates and hulls that is not in full blast with Naval orders." William H. Webb, a shipbuilder just commencing the seagoing ironclad *Dunderberg,* wrote in August 1862 that New York engine builders were asking "fabulous" prices.[17] To eliminate the production bottleneck, Fox could only go west.

Western industry had already produced gunboats for the Navy at places such as Cincinnati, St. Louis, and Carondelet, Missouri. Some were converted from river steamers and some were built for the purpose, but during 1861 even the vessels purpose-built as gunboats were constructed of wood with iron armor. River navigation demanded shallow draft, so riverboats tended to be built lightly and cheaply, with inefficient engines that took full advantage of the almost inexhaustible supplies of fuel and fresh water.[18] Heavy ships, built entirely of iron, were in fact more of a novelty on the western rivers than on the Atlantic coast.

Cincinnati nominally had a boatbuilding industry upon which to base ironclad construction, but it was neither large nor healthy. In 1859, Charles Cist recorded that the city contained three steamboat yards. Steamboat building, he observed, had been declining for years, and repairing and refitting was the yards' major occupation. Four hundred men generated $400,000 worth of business. According to the census of 1860, Hamilton County, Ohio (the county in which Cincinnati lay), claimed eleven ship- and boatbuilders with a total product of $265,214. Employment had declined since Cist wrote a year earlier; only 232 hands worked in those eleven yards, fewer than those who made window sashes and well below the number who brewed beer for their living.[19]

In other areas vital to iron shipbuilding, Cincinnati fared better. The

city harbored a number of men skilled in the metal trades, including 151 who worked in smithies, 112 brass founders, 1,544 ironworkers, and 1,414 who made "machinery, steam engines, &c." Across the river in Cincinnati's Kentucky suburbs of Newport and Covington, another hundred men made iron. Clearly, the city possessed the skilled labor of which the *Commercial* boasted. The agglomeration of specialist firms made urban Cincinnati a highly favorable environment for custom production.[20]

Cincinnati shipbuilders also had some experience with armored ships. In May 1861, then-Commander John Rodgers had purchased three wooden side-wheel riverboats, which Cincinnati's Marine Railway and Drydock Company converted into the gunboats *Tyler*, *Conestoga*, and *Lexington*. Later in 1861, the wooden-hulled ironclad gunboats ordered by the Army were designed in Cincinnati by Naval Constructor Samuel Pook, and Rodgers supervised their construction. The seven "City"-class vessels that resulted were all built by James B. Eads in Carondelet and Mound City, Illinois, but Eads's subcontracting and supply network stretched through Cincinnati and as far as Pittsburgh. The iron armor for his vessels came from three firms, including Alexander Swift & Co. of Cincinnati.[21]

The next group of purpose-built river gunboats, authorized in April 1862, included both wood- and iron-hulled ironclads. The iron-hulled *Marietta* and *Sandusky* were to be built by Tomlinson and Hartupee of Pittsburgh, while six more iron-hulled ships were put in hand at St. Louis and the wooden-hulled *Ozark* was to be built at Mound City. Southern Ohio received a share of this work, as Joseph Brown of Cincinnati built the wooden-hulled *Chillicothe, Indianola,* and *Tuscumbia*. Excepting Brown's vessels, during the year ending September 1, 1862, Cincinnati firms built only four steamboats, aggregating 654 tons.[22]

Even the iron-hulled riverine ironclads were nowhere near as complex and heavy as their seagoing counterparts. The Marietta class, for example, was somewhat broader than the Tippecanoe class but much shorter and shallower. The two Mariettas carried armor only six inches thick on the turrets and 1 1/2 inches on the sides. Eads's Milwaukee class, about as long but broader and much shallower than the Tippecanoes, had 8-inch turret armor (equal to the original *Monitor*) but side armor only 3 inches thick. Because riverine service demanded that everything

else be subordinate to shallow draft, all of the river gunboats had relatively light construction and broad, scowlike hulls that disqualified them from oceanic operations.

As early as March 1862, however, the Navy had begun to explore the possibility of building seagoing ironclads west of the Alleghenies. Cincinnati contractors had also been exploring possibilities, albeit with little initial success. Miles Greenwood, already making gun carriages and cannon for the Army, sought drawings from which to build Navy gun carriages in September 1861. Swift, his interest piqued by the armor he rolled for Eads, asked the Navy in June 1862 for specifications for gunboats, but Welles politely reminded him that Navy's April advertisement required bidders to prepare their own designs.[23] When wooden hulls were contemplated, Swift and Greenwood, with no shipbuilding experience, did not stand out.

Miles Greenwood was the better known of the two businessmen. Born in Jersey City, New Jersey, in 1807, Greenwood moved with his family to Cincinnati in 1817. At the age of eighteen, he joined Robert Owen's utopian community at New Harmony, Indiana, for two years before moving to Pittsburgh to work in an iron foundry. In autumn 1828, he returned to New Harmony and opened his own foundry, but it soon closed and he went back to Cincinnati. About 1832, he opened another foundry, which by 1859 employed five hundred men. Soon after the start of the Civil War, he had seven hundred hands making cannon, gun carriages, and caissons, as well as converting forty thousand flintlock muskets to rifled percussion-cap pieces. The machine department made steam engines, planing and saw mills, mill machinery, and printing presses. Other divisions of the firm made simple consumer products like stoves, hinges, and radiators.[24]

Greenwood was the sort of practical manufacturer who had "risen from the shop floor to ownership yet retained [his] direct engagement with the tangled complexities of production." Insofar as can be ascertained, his firm was a proprietorship. Different divisions of it specialized variously in custom production, or the manufacture of goods individually crafted for a purchaser, made singly to discrete specifications; batch production, in which producers made their products in lots of varied size, often on the basis of aggregated advance orders; and bulk pro-

duction, which used swift but relatively simple technologies and relatively unskilled workers to produce staple goods in large quantities with a fairly stable product array.[25]

Less is known about Alexander Swift. Born in September 1813 on a farm near Cincinnati, he found farming uncongenial and chose a trade. Unlike Greenwood, Swift did not come up from the shop floor, at least not the machine shop floor. He had been a tanner, and he and his partner Seth Evans purchased a rolling mill at a bargain in 1857. Both were "excell[en]t men tho not experienced in th[ei]r line." To compensate, they hired men experienced in ironworking as managers: Henry Westwood as superintendent and Gustavus Ricker as chief clerk. Like Greenwood's firm, Swift's was unincorporated. The partners had invested some $20,000 to purchase the mill, and by early 1863, Swift & Co. was worth at least $100,000.[26]

Swift's principal business was iron manufacturing. His ironworks produced various sizes and shapes of iron, such as the armor plates they made for Eads, but their bar, sheet, and plate products were all made from a very few varieties of metal. They thus straddled the boundary between batch producers and bulk producers: while many of their employees were men of considerable skill, many others were merely laborers, and although they finished iron in many shapes, the material itself differed little from order to order. Being primarily iron manufacturers, Swift & Co. did not have the expertise with machinery it would need to take on something as complex as an ironclad. Swift turned to the Niles Works to supply the deficiency.

Niles Works, run by Henry A. Jones and Charles W. Smith, employed some three hundred men in 1856 and about the same number in 1859. Judged by the credit-rating firm R. G. Dun & Co. to "carry on every branch of their bus[iness] managed v[ery] judiciously by men who thoroughly understand it," they possessed "1st rate cr[edit]." In November 1860, they were capitalized at about $260,000.[27]

Niles Works operated both a foundry and a machine shop, making "iron and brass castings of every description; boilers, heavy forgings, tyre-lathes, boring mills, planing machines . . . made to order" as well as castings and machinery for rolling mills, marine engines, oil presses, and blast furnaces. The firm specialized in the Southern trade, taking full advantage of its location: "Every article required in Louisiana or Missis-

sippi, can be furnished to the planter by these works more cheaply than by the Philadelphia founderies [*sic*] . . . thereby saving the delay and expense incident to its reception via New Orleans."

Because its principal business was with the South, the outbreak of war hit Niles Works hard. After a period during which, "like the bal[ance] of the trade," it was "hard up," by April 1862, it was financially "all right & easy."[28] The variety of its products and their manufacture to order rather than for stock places Niles Works squarely in the category of custom manufacturers, and this experience with "one-off" manufacturing helped Swift's firm to develop its shipbuilding organization.

Although rebuffed over the spring 1862 gunboats, Swift & Co. did not give up. Swift's horizon was evidently beyond the banks of the Ohio, because Swift & Co. inquired in June whether the Navy wanted vessels for coastal or river use. The firm appears to have had contacts within the Navy, knowing that harbor and river monitors would be the next class procured. In July, Swift wrote, "We have the capacity to make some Gun Boats, and would be glad to have a contract for the Western Waters or the coast. Say wood or iron—would prefer iron. We will make two or [blurred] Monitors at Eastern [price?] for the Harbor and Coast Survace [*sic*] or for the Mississippi River." Swift stressed that he owned an iron-rolling mill and had already engaged Niles Works, "the largest machine shop in the West," to assist. Welles wrote that the Navy had contracted for as many monitors as it then required, but the Swift/Niles partnership united areas of expertise (ironwork and machinery construction) that made it quite attractive.[29] When the Navy decided to build monitors west of the Alleghenies, firms already corresponding with the Navy Department would come most naturally to mind.

Cincinnati manufacturers were on the lookout for business, and when the Tippecanoe class provided an opening, Swift and Greenwood responded promptly.[30] Both firms knew that the Navy placed a high value on speed of construction, and each firm showcased its advantages in that line. Greenwood's proposal, signed by his superintendent, Nathaniel G. Thom, stressed that firm's war work: "The well known character of our establishment for promptness and energy and the interest we have taken in putting down the present rebellion will I doubt not be a significant guarantee that the work will be pushed forward with the utmost vigor and rapidity." Swift's proposal, signed by his secretary Gustavus Ricker

and Charles W. Smith of Niles Works, accentuated the benefits of their partnership, pointing out the value of integrating an iron supplier and an "extensive Locomotive works" to build the ships as quickly as any establishment in the country.[31]

The Swift/Niles partnership and Miles Greenwood received the Tippecanoe-class contracts they sought. Other successful bidders included Harrison Loring's City Point Works; Secor & Co.; Snowdon & Mason of Pittsburgh; and William Perine of New York (who promptly but informally transferred his contract to a newly created firm of convenience called Perine, Secor & Co.). The contractors split naturally into two groups: experienced builders (City Point and Secor/Perine Secor) that were already building Passaic-class monitors, and expansion builders (Swift/Niles, Greenwood, Snowdon & Mason) with no such experience.[32] The contracts required the shipbuilders to deliver their ships within six months of September 1, 1862. Since the Navy wanted ships posthaste, besides the six month deadline, each contract included a penalty of $500 per day for late delivery and a bonus of $500 per day for early completion. Comparing these contracts to those issued for wooden gunboats at about the same time shows how serious the Navy was about wanting the monitors as quickly as possible; the wooden gunboat contracts contained no incentive clause and the penalty for late delivery was less.[33]

In building the Passaics, the Navy had similarly pushed the contractors hard for speedy construction. In that early phase of the monitor program, Ericsson's "first team" of Continental and Delamater outshone the rest. Each had gained experience and expanded its facilities while building the original *Monitor,* and both enjoyed the benefits of "lead yard" status—being first into the market for materials and having intimate daily contact with Ericsson, the designer, to resolve difficulties. Continental completed its first ship, the *Passaic,* in late November 1862 and its second, the *Montauk,* in mid December 1862. The gap between *Montauk* and Continental's third ship, the *Catskill,* was longer; although a month's difference had been allowed, the *Catskill* was over two months behind the *Montauk* when completed in February 1863.

Harlan & Hollingsworth, the City Point Works, and the Atlantic Works were close behind. Each had to cope with a form of heavy construction that was new to it, but all were experienced ironworkers and all had built at least a few iron ships. The Passaic-class *Patapsco* was Harlan & Hol-

lingsworth's first monitor, but commercial experience (and perhaps having the tools and equipment for iron shipbuilding) seems to have made up for the disadvantages of being so far from Ericsson's New York City headquarters. The firm launched the *Patapsco* in September 1862, behind only the lead ship, the *Passaic*. During the fitting out period, Ericsson's personal involvement made it easier for Continental to resolve design difficulties, and that firm forged ahead to complete the *Passaic* and *Montauk* first. Harlan & Hollingsworth completed the *Patapsco* only 2 1/2 weeks behind the *Montauk*.

City Point, which had built a few iron vessels before beginning its monitor, also did well. Loring did not accept his contract for the *Nahant* until May 5, 1862, but despite the late start, he completed it in eight months, three days before Harlan & Hollingsworth. Curtis, who like Loring had some commercial experience, completed the *Nantucket* in late February 1863, but he had only accepted his contract on April 28, 1862.

Secor & Co. in Jersey City was a special case. The firm had some experience in building dry docks, but none with iron ships, and although its subcontractor Joseph Colwell had probably acquired some ironworking experience from his father and uncle, he had never built iron ships before either. The Secors and Colwell started their shipyard from scratch (Colwell naming the foundry and machine shop the Fulton Foundry), but their physical plant grew rapidly, and they quickly made up for their initial deficiencies. Their greatest assets were their own drive and energy and the vast resources of the New York metropolitan area, where men, materials, and tools were relatively easy to obtain in mid 1862. They used those assets to finish their *Weehawken* in mid January 1863; the *Camanche* took longer, but, as we shall see, that was a special case indeed.

Despite its experience building iron ships for the commercial market, the firm of Reaney, Son & Archbold of Chester, Pennsylvania, brought up the rear, probably because of its small capital and equipment and relatively limited labor pool. Working as Ericsson's subcontractor, it completed the *Sangamon* in February 1863 but did not finish the *Lehigh* until April.

The nine Passaic-class monitors had been contracted for completion in four or five months. The ships actually took from eight to thirteen months, with an average building time of nearly nine months The contractors did not see these extended construction periods as cause for pes-

simism, however, and they were not ruined by them. Inflation had appeared, but a retrospective look at 1862 shows that prices had risen only 14.1 percent over the levels prevailing in 1861. Although there were slowdowns, many of them came near the end of the construction period, when the bulk of the materials had already been purchased, so materials inflation did not pinch the contractors too harshly. Shipbuilders could still find skilled labor, although it was becoming scarcer and more costly. Tools and materials, although more expensive, were still available at reasonable cost and with reasonable promptness.

The Passaic design had undergone changes, but only the switch to a 15-inch gun had involved extensive work—overall, the design remained fairly constant. One reason was that changes meant delays, which were anathema; in September 1862, the Union had completed only three oceanic ironclads (one of which had already failed), and the Passaics were the Navy's highest priority. Another reason was that in the absence of significant combat and operational experience, few requests for changes came from the fleet. Finally, Ericsson himself oversaw the development of the Passaics and maintained personal control of their design. Ericsson appreciated the trade-off between urgency and elegance, but the inventor's relations with Fox played a role as well. Fox greatly respected Ericsson's engineering judgment, while Ericsson embodied independence and strong self-confidence. If Fox asked for something unreasonable or excessively time-consuming, Ericsson could say no and make it stick.

The circumstances of relatively low inflation, ready availability of materials and labor, and design constancy appear to have given contractors a mistaken impression of what ironclad construction would be like. Although building iron ships clearly required different tools and skills than building wooden ones, the changeover did not appear to be too daunting for a good machine shop or ironworks—in modern terms, there would be a learning curve, but it did not seem not insurmountably steep. The Passaic-class contractors were making mistakes and having to grope for ways to deal with new technologies, but they were still making money.

None of the parties fully considered the problems of expanding ironclad production into western areas where iron shipbuilding was virtually unknown and the machinery and ironworking industries were

less robust. Building heavy ships on western waters involved major uncertainties and startup expenses, which were not recognized in the contracts for the Tippecanoe-class vessels. The contractors apparently did not ask for, and the Navy certainly did not volunteer, any compensation for the increased risk and expense the western shipyards faced. At least, the effects of river levels, availability of skilled labor, and ability to establish new facilities might have been considered.

Once they had won their contracts, the successful bidders sought to begin work immediately. Two challenges stood in their way. Both experienced and expansion yards needed detailed information about the ships so that they could order the materials they needed, and the expansion yards needed first to create the physical facilities to build the ships.

Obtaining detailed information was each shipbuilder's top priority, because without it he could not order material. Prompt ordering was vital, although the lead time required to obtain the material varied depending upon the items involved. Plate and angle iron were relatively easy to get, while forgings had to be made to order. Castings, especially large ones, took even longer than forgings, each requiring its own full-size wooden pattern and mold.

A few days' delay in ordering material could make weeks of difference in its delivery. Most ironworks, machine shops, and foundries operated on the basis of first in, first out; at best, deliveries could begin a week or two after the material was ordered.[34] In a competitive market, where several contractors sought similar material, being first was crucial: the earliest contractor in the queue might receive his initial delivery in a week; the second would not get any iron at all until some weeks later when the first order was finished. Without precise information, however, being first could backfire. If a contractor ordered the wrong material, he would have to reorder; besides going to the foot of the queue, he would be stuck with a shipyard full of iron that he could use only with great difficulty and expense. Finally, as more contractors entered the market, the demand increased and with it the price. To assure themselves of a good price, shipbuilders had to order early.[35]

Deferring for the moment the issue of detailed information, the second challenge was unique to the expansion contractors' inexperience in shipbuilding: none had any of the physical plant or specialized tools needed to build the ships for which they had contracted. Most of the ex-

perienced shipbuilders had had to overcome similar problems to build their Passaic-class ships. Those firms with ironworking experience had to expand their small prewar yards sharply; such firms included Boston's City Point and Atlantic Works, New York's Continental and Delamater, and Chester's Reaney, Son & Archbold. The Secors and Colwell had to build a shipyard from scratch. Even the relatively well equipped Harlan & Hollingsworth had had to grow. Each had done so in the relatively favorable environment of early to mid 1862. By late 1862, establishing an iron shipyard was becoming more expensive and difficult.

In Cincinnati, Greenwood solved his problem straightforwardly by contracting with John Litherbury to rent Litherbury's existing shipyard at the foot of Fulton Street, about a mile from Greenwood's shops. Litherbury had earlier converted a steamboat into the gunboat *Lexington,* then supervised construction of the four City-class gunboats that Eads built at Carondelet. The advantage of Greenwood's arrangement with Litherbury was that Greenwood obtained a prepared site with a minimum of delay; the disadvantage was that Litherbury's shipyard was minimally equipped and set up to build wooden ships. Greenwood planned to get his iron from Phillips & Son of Covington, less than two miles away by water (Fig. 3.2).[36]

Even with a shipyard site in hand, Greenwood needed tools. Besides the general-purpose machines common to any large machine shop enterprise, iron shipbuilding required specialized tools. Shipbuilders needed facilities for bending beams and plates, and heavy-duty shears and punches to cut inch-thick armor plate to size and to punch rivet holes in it. Plates could be prepared with simpler equipment, but the specialized machinery more than paid for itself. Using hand tools on the job site, a man could drill fifteen to twenty rivet holes per day. In the shop, using a powered punch, he could produce that many in a minute.[37] Greenwood's superintendent, Thom, began to investigate tools and shipbuilding methods even before the monitors were advertised, spending the week of August 11-19, 1862, in New York City for the purpose. Heavy punches and shears were on his mind, and he found that it would take four to six weeks to obtain them. Besides purchasing specialized tools, Greenwood made some of his own.[38] He began the actual construction of his vessel, soon to become the *Tippecanoe,* about September 28, 1862.[39]

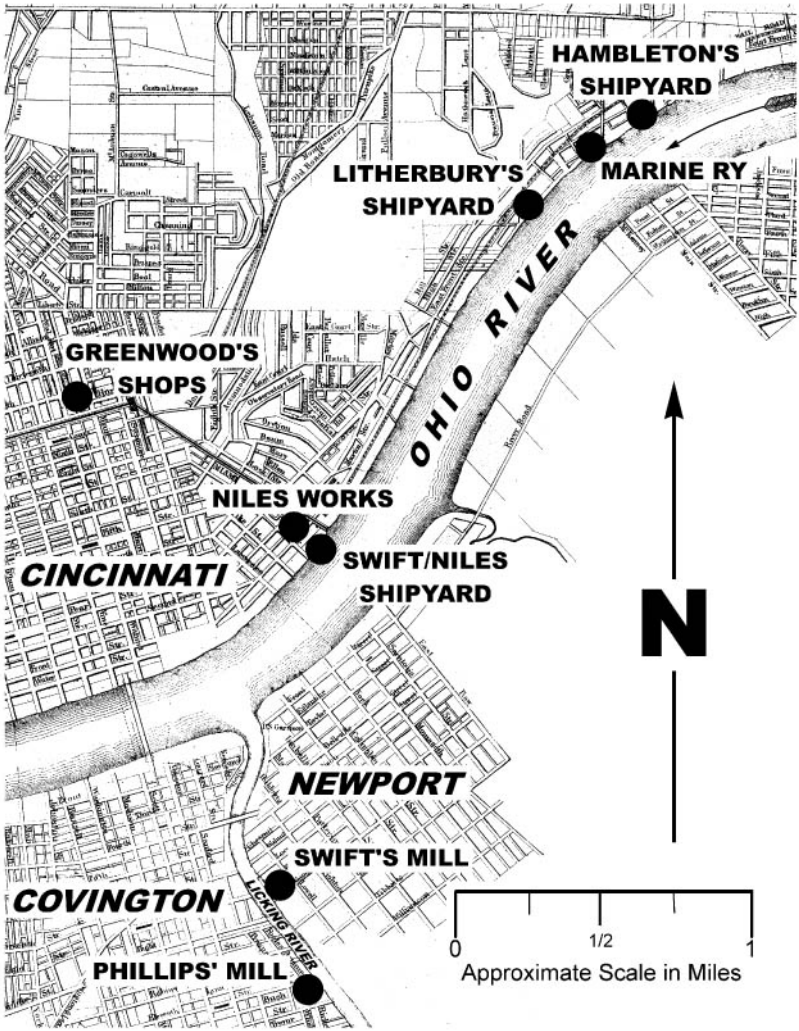


Fig. 3.2. Map of the Cincinnati, Ohio, area showing locations of monitor contractors' shipyards and ironworks. Adapted from Gilbert & Hickenlooper's map for *Williams' Cincinnati Guide*, 1866.

Swift and Niles Works started their facilities from bare ground on a lot just across the street from the Niles Works shops (Fig. 3.3), less than a mile by water from Swift's rolling mill. Their yard lay about three-quarters of a mile down the river from Greenwood's operation. Swift also needed tools, most of which had to be specially built, but Alexander Swift asserted in retrospect that "the getting up the tools was no hindrance to the work." Like Greenwood, Swift and Niles bought some tools from eastern manufacturers and made others themselves; either way, he stated, they had everything they needed when they started work. Swift's first ship, the *Catawba,* and his second, the *Oneota,* were begun in early October, about the same time as Greenwood's *Tippecanoe.*[40]

Fig. 3.3. View of the Cincinnati waterfront, ca. 1865. This view, part of a panorama taken by H. Rhorer from atop the unfinished suspension bridge, looks upriver toward the waterworks (the waterfront building with tall smokestacks). Swift's yard lay just this side of the smokestacks, between the waterworks and the public landing. From the collection of the Public Library of Cincinnati and Hamilton County, Inland Rivers Collection, pl. 998.

In Pittsburgh, Snowdon & Mason had practically nothing with which to build their vessel, the *Manayunk*. Snowdon & Son—John Snowdon and his son John N. Snowdon—owned the Vulcan Iron Works and built machinery and engines in Brownsville, some thirty miles southeast of Pittsburgh. Another Brownsville man, Albert G. Mason, was a boatbuilder, and the Snowdons joined with him to bid on the monitor.[41] Of the six successful bidders for Tippecanoe-class monitors, Loring, Greenwood, and Secor were established firms, but the other three (Swift/Niles; Snowdon & Mason; and Perine, Secor & Co.) were entities created expressly to build monitors.

Snowdon & Mason did have boatyard facilities at Brownsville, but Mason's small-scale operation was inadequate.[42] He had built only wooden vessels there, and besides, the monitor would be too big to fit through the locks on the Monongahela River. Accordingly, Snowdon & Mason rented land farther down the Monongahela, across the river from Pittsburgh, where they built a shipyard and shop from the ground up. They bought an established machine shop on the Pittsburgh shore, and a second shop elsewhere in the city. The Snowdons shut down their Brownsville shops and brought their workmen to the new "gunboat yard" in Pittsburgh.[43] Their new shipyard lay only three hundred yards from its principal supplier of iron, Lyon, Shorb & Co.

Snowdon & Mason, like the two other expansion shipyards, met one condition essential for successfully building iron ships: each was at the center of a cluster of well-developed metal production and engineering industries. Yet Pittsburgh, like Cincinnati, had only a small industrial base for shipbuilding. Iron-hulled vessels had been built in the 1840s, but Pittsburgh's building in the 1850s was confined to small wooden ships of less than 500 tons displacement. The Panic of 1857 brought Pittsburgh shipbuilding to an abrupt end.[44]

All the monitor builders needed the same physical plant: facilities in which to build the hulls, facilities in which to build the machinery, and specialized shipbuilding tools and equipment.[45] To obtain them, the expansion yards followed different courses. Greenwood chose the most conservative path by renting an existing shipyard from an experienced builder of wooden-hulled ships. Snowdon & Mason's partnership took a middle way, joining an ironworker with an experienced shipbuilder but starting their shipyard from scratch. Swift and Niles were the least in-

fluenced by the experience of building wooden ships. The western yards' success in building monitors would be inversely proportional to each firm's reliance upon wooden shipbuilding expertise.

As has been noted, the first thing any contractor needed was detailed information about the ship he was to build. For the harbor and river monitors, that information was sparse indeed. The Navy gave Harrison Loring a contract on August 30; nearly two weeks later, he wrote plaintively to ask for "some of the general dimensions." Snowdon & Mason sent their foreman boilermaker, Jacob Graser, to New York for two weeks to learn everything he could about "the vessels as well as the boilers." Nathaniel Thom, Greenwood's superintendent, spent three weeks in New York seeking information; all he could obtain were sketches, for which Stimers disclaimed responsibility.[46]

On the Navy side, Stimers asserted on September 13 that preparations for the harbor and river monitors were going rapidly forward. The contractors were "so eager to get plans and lists of iron that they really retard me to some extent. . . . Capt Ericsson's recent experiences are so much in favor of having very complete general plans to commence with that his draughtsman is still at work upon the one for these vessels," he wrote Admiral Gregory. "Sending this information from headquarters where we have the experience of all that has gone before will facilitate the work more than these contractors will ever appreciate."[47] Stimers responded to the contractors' complaints by increasing his drafting staff. On the harbor and river program alone, Stimers's draftsmen issued thirty sheets of drawings (like Fig. 3.4) in September 1862, forty-five in October, and seventy-six in November.[48] Yet whatever the promise of eventual facilitation, Stimers could do nothing to ease the shipyards' immediate problem: two weeks after the contracts had been awarded, the shipbuilders still had no drawings or even specifications. For the contractors, the clock ticked in dollars: two weeks delay at $500 a day was $7,000.

Because he could not send plans when the contracts were executed, Stimers recommended that the Navy extend the delivery dates by the fifteen days it took to send the first plans.[49] Those plans were not the "very complete general plans" Ericsson had mentioned, but they at least allowed shipbuilders to begin to order materials: the first drawing, sent on September 13, 1862, was a list of the angle iron required for the vessel (it was revised two days later, presaging what would later happen). The

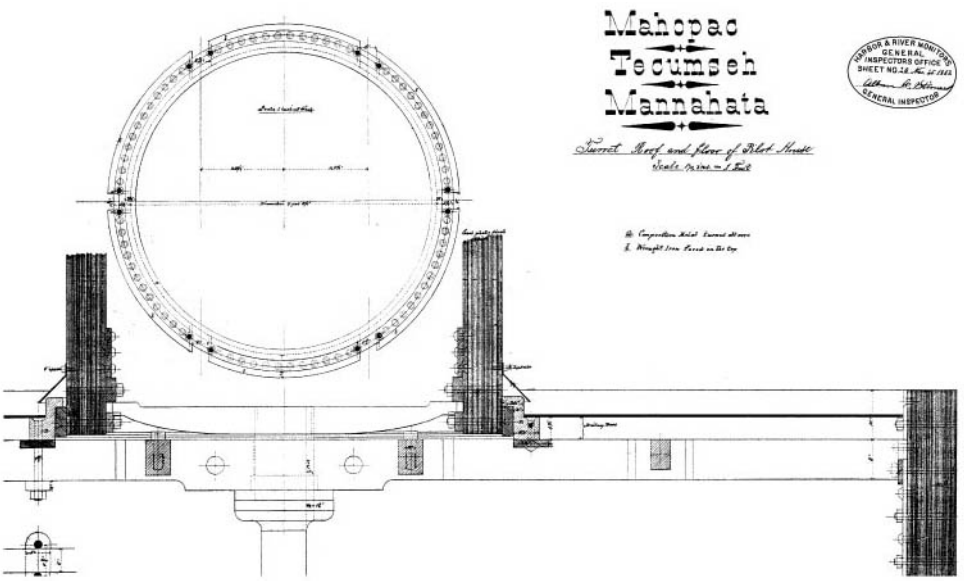


Fig. 3.4. Typical drawing for the harbor and river monitor program. This plan, a side view of the joint between turret and pilot house, clearly displays the "Harbor and River Monitors" stamp with General Inspector Stimers's signature. National Archives and Records Administration, Record Group 19, BuShips Plan 2-8-19.

plating list did not leave Stimers's office until September 22, when the fifteen days reprieve granted the contractors by postdating the contracts had already been half-consumed.

The next drawing completed was that of the ship's boilers, sent on September 24, 1862, and received in Cincinnati the next day. The boiler plans, however, had to be returned for alteration and were not seen again until late January 1863. The general plan did not appear until October 4, 1862, and the scale model of the hull, needed by the contractors to ascertain the size of the keel plates, was not sent until October 7, 1862.[50]

Under the prewar system, or in fact under the system used for the first three ironclads, the slowness of the central office would have meant little. Each shipyard, working from the specifications, would have made its own model, developed its own materials lists, and ordered its own mate-

rials. Yet as Stimers later observed, because "these vessels were all of novel construction and many of them were being built by people who were not in the habit of building sea-going vessels, anyway," the Navy decided to require the contractors to work to the plans it furnished. "We were not allowed to proceed with a single bolt without the drawings," one contractor noted, and another recalled that his firm had been strictly forbidden to go ahead without plans.[51]

The Secors and Harrison Loring were responsible for four of the seven Tippecanoe-class contracts the Navy initially let, and both were building Passaic-class vessels. Contractor inexperience thus could not have been the only impulse behind the Navy's decision to enforce strict configuration control. For one thing, Ericsson, who had originated the Tippecanoe design, had a very high reputation, and Fox wanted to ensure that his wishes were followed.[52] For another, the Navy had begun to recognize that in the application of high technology, apparently insignificant details could have a far-reaching impact. Most important, the Navy wanted each of its ships to incorporate all available improvements. This latter motive, based upon an apparent perception that a "perfect" design could be developed, would come to dominate the harbor and river monitor program.

The fixation on better instead of good enough first appeared in the growth between the original specifications shown to bidders in August 1862 and the modified specifications sent to contractors in October. Among the changes, the deck armor was doubled in thickness from 1 to 2 inches, the pine armor backing became oak, auxiliary boilers were added and horizontal tubular boilers replaced the smaller Martin boilers originally specified. The contractors only became aware of these changes when they received the specifications and the first few drawings in late September or early October 1862. Specification growth also delayed drawing production; as Stimers noted, experience in building the Passaics showed weaknesses upon which the Navy wanted to improve. The contractors later claimed compensation for the changes, but more damaging than increasing the cost, the changes delayed the plans: "It took time to study out just how we would do it, instead of tracing plans which had been worked from before."[53]

The effects of specification growth were still in the future when the Navy decided that it had not contracted for enough Tippecanoes. Origi-

nally, seven contracts had been let around September 1, 1862, all for six months and $460,000. At that time, the design for Fox's pet project, the "light-draft" monitors, still seemed to be progressing rapidly. Because Fox hoped to begin building light-draft monitors soon, no more Tippecanoe-class contracts would be issued. This explicit allocation of national industrial resources was among the first of its kind.[54]

Yet during September, the long-promised plans for the light-draft monitors kept receding before Fox's eyes. He had begun pressing Ericsson for them in August, hoping for a 4-foot draft, but Ericsson's workload did not permit him to expedite the project. In mid September, Ericsson gave up on the idea of a vessel with a 4-foot draft, but by late September, he was working on a design with a 6-foot draft, the sketches for which he finished on October 5 and sent to Washington on October 9.[55] Meanwhile, contractors were looking for work; on September 12, 1862, an agent of Harlan & Hollingsworth visited Stimers to ask about building a monitor.[56]

In early October, Stimers was still advocating that the Navy wait and build light-draft monitors. Fox, however, had evidently decided to go ahead with more "fast monitors" while waiting for the light-draft plans. On October 1, Fox telegraphed Loring, Harlan & Hollingsworth, and the Niles Works, offering each firm a vessel on the same terms as before. Niles Works, the first to accept, agreed without additional conditions and immediately obtained a second contract as Fox had proposed. Harlan & Hollingsworth dithered for several days over whether to wait for a light-draft monitor, but the still-incomplete plans for the light-drafts combined with "one sett [*sic*] of our ways being now vacant since the launch of the 'Patapsco' " to impel the firm to accept. Originally asking $500,000, they acquiesced to $460,000 and received a contract for one ship in mid October.[57] Loring wanted an additional vessel, but because he tried to impose conditions that Fox would not accept, he did not get a second contract.[58] The Tippecanoe class would thus total nine ships.

At the same time, the Navy centralized the monitor program under Stimers and Gregory. Cincinnati and Pittsburgh had been in the western area in which Captain Joseph Hull supervised all Navy shipbuilding. On September 26, 1862, Welles transferred responsibility for the western monitors (at that time the *Tippecanoe*, *Catawba*, and *Manayunk*) to Gregory, with Chief Engineer James W. King as supervising engineer.[59]

The early stages of the acquisition process were thus complete, but with hidden problems that would soon become apparent. The vessels had been designed and placed for bid, but the poorly defined design was already growing and changing. The government had decided to expand the industrial base for building ironclad vessels, but it had not taken into account in its contracts the conditions facing western builders. To support its urgent need for armored vessels, the Navy had established the Inspectorate of Ironclads in New York, but Fox's overgenerous grant of authority to this "monitor office" left the ironclad program without meaningful independent technical oversight. Successful and timely production of the new monitors would be a major task.

CHAPTER 4

Mobilization on the Ohio River

Cincinnati's waterfront was busy in late 1862. Joseph Brown and McCord & Junger had finished the wooden-hulled riverine ironclad *Chillicothe* in September, and were building the similar *Tuscumbia* and *Indianola*. As winter approached, both Greenwood and Swift were working hard to begin their monitors; their experiences illuminate the problems faced at one time or another by all of the monitor builders.

Greenwood had rented John Litherbury's boatyard as a construction site. It was little more than a lot with a few sheds, and Greenwood needed many things to build an iron ship that were not needed for wooden construction. Like the frames of wooden ships, the frames for iron vessels were laid out full sized in a "mold loft" (one of Litherbury's sheds was such a mold loft). Many of a wooden ship's structural members would be hewn from wood that already possessed the proper curves; others would need to be scarphed together and a few pieces would be steamed and bent. Iron frames, however, all had to be bent to shape. To do this, the shipbuilder needed a "bending floor" or "bending table." Bending tables were large, heavy plates in which holes were arranged in a regular pattern. Metal blocks of appropriate curvature, called bending blocks, were secured to the table with pins inserted into the holes, and the heated iron beams or plates were forced into shape around them using sledgehammers or, occasionally, hydraulic rams.[1]

The bending process required a good deal of lead time. First, drawings had to be made for the bending blocks. Wooden patterns then had to be made from the drawings and iron castings made from the patterns. Only then could the iron frame be properly bent. After bending, it had to be punched or drilled for rivets before being erected. Nathaniel Thom's diary notes that Greenwood was preparing bending tables in mid October; Swift probably did so at about the same time.[2]

The shipyard itself also needed preparation. The first requirement was a shiphouse, a large shed that more or less protected the ship and the workmen from inclement weather. Litherbury's shipyard included a small shiphouse, but it was not large enough to hold a monitor, and Greenwood had to build a new one. At their site, Swift and Niles had only a lot; they had to build two shiphouses, one for each monitor. The shipbuilders also needed to grade and level the areas in their yards where their ships would be built and begin to make the blocks upon which the keels would be laid down. Once the general plan of the ships was received, the keel blocks could be finished and set in place.[3]

Besides specialized tools, each shipbuilder needed general-purpose tools to build the ships' machinery. The Swift/Niles consortium, with access to Niles Works' shops, had plenty of machines such as shapers, planers, mills, and lathes. Greenwood found he needed more general-purpose tools, and his superintendent, Thom, had to arrange in December 1862 to rent a large planer, boring mill, and engine lathe. He got the use of the tools, a blacksmith's fire, and two pattern benches for $12 per day.[4]

Organizing a network of subcontractors and suppliers was a key element in the shipbuilders' preparations. (In overly simple terms, suppliers provide material or equipment, such as a pump, to the shipbuilder, while subcontractors provide the labor to perform a task.)[5] Among Philadelphia shipbuilders, a single wooden steamship usually involved twenty to thirty subcontractors.[6] In this area, the western firms had to start practically from scratch.

Few subcontracting relationships are evident in the construction of the western harbor and river monitors, although Greenwood had more than Swift. Swift & Co. and Niles Works accepted the contracts for the *Catawba* and *Oneota* as partners rather than as contractor and subcontractor; although Swift appears to have dominated, it is difficult to determine from surviving documentation exactly what percentage each firm contributed, and contemporary correspondence refers as frequently to Niles Works as to Swift. Swift's bookkeeper, Edward A. Jenks, later stated flatly, "There were no sub-contractors on those two boats [the *Catawba* and *Oneota*]."[7] In Greenwood's case, the machine shop was part of his own firm; while he rented John Litherbury's shipyard, Litherbury's involvement with the *Tippecanoe*'s construction was vanishingly small.[8]

Thom kept a diary of his business affairs, and the portions of it that became part of later court proceedings give an incomplete but unusually detailed view of the shipbuilding process.[9] Greenwood engaged and supervised his own workforce and subcontractors without using Litherbury as an intermediary. For example, Greenwood contracted on October 14, 1862, with Richard Tudor to build the boilers, and on October 5, 1863, with George H. Grey to "put up turret." In September 1863, a Mr. Morris agreed to fit the tubes for the main condenser. Greenwood also considered having a Cincinnati firm, Hampton & Morgan, install the wooden armor backing, but Thom noted: "I don't think this contract was ever made. There were so many of these propositions made that I don't remember." By contrast, in Pittsburgh, Snowdon & Mason had a boiler shop of their own, and Swift also built his own boilers.[10] In this pattern of subcontracting, Greenwood followed the traditional model of shipbuilding in wood more closely than either Swift or Snowdon & Mason.

The single biggest supplier for each shipbuilder would be the firm that provided the iron. Greenwood had contracted for iron with the firm of Phillips & Son (also called Phillips & Jordan) of Covington, Kentucky, just across the Ohio River from Cincinnati, which agreed to furnish all the plate needed at 5 3/8 cents per pound, although it later renegotiated the contract. It appears that the actual price Greenwood paid in September 1862, for plate, bar, and angle iron, was about 5 cents per pound.[11] For the Swift/Niles consortium, the iron needed to build the vessels would come from Swift's own ironworks, also across the river in Newport, Kentucky. (Swift's mill sat near Phillips's, with the Licking River between them; see Fig. 3.2.) In Pittsburgh, Snowdon & Mason would get their iron from nearby Lyon, Shorb & Co. Easy access to local suppliers of iron was thus common to all three operations.

The government inspector assigned to the Cincinnati monitors arrived in early November 1862. For this job, Stimers chose Chief Engineer Charles H. Loring, a naval engineer of eleven years' service. Loring had risen almost as rapidly as Stimers, from third assistant engineer in February 1851 to chief engineer in March 1861, and he had been first assistant engineer aboard the USS *Merrimack* when Stimers was the *Merrimack*'s chief engineer. Stimers thought highly of him, writing Fox, "I am glad Loring is going to Cincinnati. He has ability, tact and sterling character." A few months later, Stimers wrote Loring, "I wish you were here with

me. It would relieve me of a great deal of hard work and permit me to attend to many important matters that I now have to trust to inferior hands." He went on to say that he knew of no one whom he could both rely on and spare to fill Loring's position in Cincinnati.[12]

This was high praise from the irascible Stimers, but it was well deserved, because Loring's assignment clearly carried more responsibility than its equivalent in more experienced shipyards. As Chief Engineer King wrote, when construction began, "Neither of the Heads or Superintendents of the establishments had ever seen an iron vessel, a marine steam engine or marine boiler constructed, or had they previously built work from regular drawn plans." The inspector, he said, became "the director of construction throughout every detail from the keels to the pilothouses, a task requiring the exercise of judgment, care, and energy."[13]

Loring and the other inspectors reported to Stimers on a regular basis, usually every two weeks. Loring's first report, dated November 11, 1862, indicates how much preparation a shipyard required. Swift had finished the shiphouse for the *Catawba* and laid her keel blocks, drawn the lines for the frames in the mold loft, and begun many of the bending blocks (also called molds). Displaying vigilance early, Loring had condemned eight of the twenty sheets of iron he inspected. The *Oneota* lagged behind, with Swift's second shiphouse still under construction, but since the two vessels were identical, the lines and molds made for one ship could be used for the other. At Greenwood's yard, the *Tippecanoe*'s shiphouse was finished, her keel blocks laid, and her lines drawn in the loft. Her sternpost had been forged and was being bored for the propeller shaft.[14] Two of the contracts' six months had passed without a keel plate being laid.

Stimers commented upon the progress of the Cincinnati vessels in his own report to Admiral Gregory. The general inspector noted that the contractors appeared to be "rather behind hand in their preparations . . . much more so than one would have suspected, to have listened to their representations of their facilities and their great anxiety to obtain all their drawings at once from this office." He observed, however, that their slowness was natural, considering that "Iron Ship building on an extensive scale, is an extremely new business in this country." Referring specifically to Swift, Loring later judged that the contractors had no facilities for building the hulls when they took the contract, although their ma-

chine shop was excellent.[15] Despite the presumed advantage of taking over Litherbury's existing shipyard, Greenwood was already beginning to fall behind.

Loring's early reports show some of the consequences of the inexperience to which King referred, difficulties to which Greenwood seemed to be more prone than Swift. While Greenwood had bent more keel plates than Swift, Swift's had been drilled for their rivets while none of the *Tippecanoe*'s plates could be punched, because the punch was not yet ready. The sternpost forging that Loring mentioned in early November had been condemned for being scant (too thin), and Greenwood would have to be remake it, as well as two of the fifteen keel plates. In two weeks, Swift had worked 649 man-days on the *Catawba* and another 138 on the *Oneota;* Greenwood had expended only 339 on the *Tippecanoe.*[16]

The eastern builders had already pulled far ahead. The Secors, who had taken on three Tippecanoes, had to expand their works dramatically and increase both their tooling and their labor force. When Loring reported in mid November that no keels had yet been laid in Cincinnati, the Secors' *Tecumseh* had all but two keel plates installed, stem and sternpost in place, and over 100 feet of the first strake of bottom plating riveted in place. The *Mahopac* and *Manhattan* were close behind.[17]

During this period Stimers's drafting office worked steadily on the plans for the ships (Fig. 4.1). By mid November, it employed sixteen men, and its output had more than doubled since September. That was still insufficient, especially since the office had begun to prepare drawings for the light-draft monitors, but as Stimers observed, "Men who can trace are in plenty, but not those who can construct."[18] The general inspector recognized the position he was in, writing, "The builders of the Harbor and River Monitors will, I fear, all be backward with their vessels and I do not wish them to throw it upon the non receipt of drawings." Fox confirmed this two days later, writing, "Greenwood and Secor are here complaining that they do not get drawings." Stimers replied, "Greenwood and Secor are simply preparing you to let them off from their forfeiture when their six months are up." He advised Fox not to commit himself, claiming to have "a very simple plan" to determine how much delay was due to the drawings.[19] Among the many drawings not issued when this exchange took place were those of the boilers, the engine keelsons (heavy

bottom frames upon which the engines rested), the armor arrangements, and most of the valves, gears, and linkages for the engines.[20]

Here the seed of standardization planted earlier in 1862 began to bear poisonous fruit. The board that reviewed the proposals received from the twenty ironclads advertisement had recommended that the Navy prepare plans upon which any contractor could bid. The board did not specify the level of detail, but previous practice had been to furnish relatively general drawings and moderately detailed specifications. Shipbuilders and contractors would comply with the specifications, but because each establishment had its own peculiar shop practices and its own customary ways of doing things, each product would differ in its details. Each establishment depended upon its experienced tradesmen and supervisors to develop sound practices over time that would satisfy the specifications.[21]

High technology and the expansion of ironclad production disrupted this system. Fast-changing new technology required adjustments that frequently seemed counterintuitive to men accustomed to the old; in many cases, established practice was the product of days or weeks of experience, not of years or decades. Some shipyards had built iron hulls before, but never of such heavy construction and never covered with armor. Additionally, as the demands of the monitor program grew, the

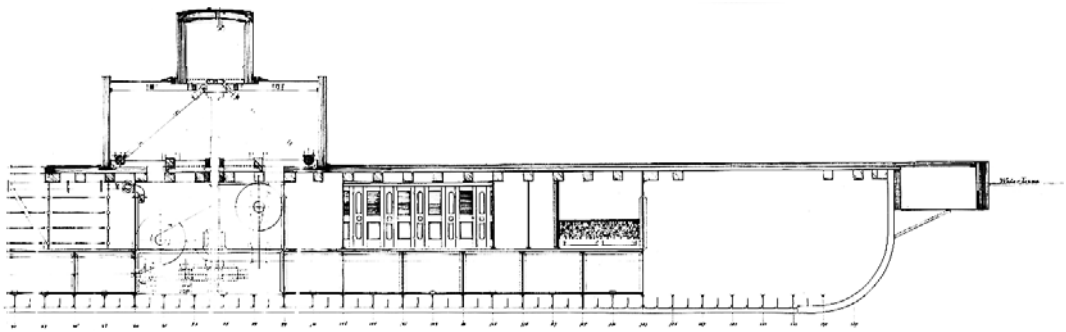


Fig. 4.1. Side view of the bow of a Tippecanoe-class monitor, from sheet 44 of the General Plan. National Archives and Records Administration, Record Group 19, BuShips Plan 7-9-9; Naval Historical Foundation photo NH 69061.

Navy turned to contractors who had no experience whatsoever with such work. In this twofold absence of established practice, builders might make apparently insignificant decisions that could have far-reaching impact. Even experienced builders could cut corners or ignore drawings, with potentially dangerous results.[22]

Stimers first faced the problem of "level of detail" as the government's inspector for the *Monitor*, where he contended with "a very great want of exactness and detail in the specifications, which makes the duties of the superintendent very responsible and onerous."[23] He had included more information in the Passaic-class specifications but found that, too, to be insufficient. On the Tippecanoes, Stimers insisted that everything be drawn out in detail. "The construction of the vessels themselves was very novel; the contractors knew nothing about such vessels or about their machinery, therefore every bolt and rivet had to be shown in the greatest detail and these were furnished from time to time as rapidly as we could furnish them," Theodore Allen, Stimers's assistant, later testified. "The contractors could hardly have carried out the desires of the Government without their being furnished with drawings."[24]

Even as the contractors began to "carry out the desires of the Government," major revisions to those desires were in the wind. There had been many changes between the original and the modified specifications, but no one considered their cumulative effect upon the ship as a whole—the changes were simply mandated. No one calculated the weight added by doubling the thickness of the deck armor or by enlarging the engines for higher speed. Even after the modified specifications were issued, Stimers observed, "from our experience & observations of the Passaic class of vessels, it was decided to add here & there additions to the strength of the vessels."[25]

Eventually, someone noticed a problem. It is not entirely clear who it was; the Secors claimed to have been the first to question the design, but Stimers later credited Ericsson. Charles A. Secor said that the firm's "attentions were called" to the specifications, finally issued during the second week of October 1862, and Secor then estimated the flotation of the vessels. Secor took the results to Washington and "told Mr. Fox that his plans and specifications for those vessels were so entirely different from the information that I got from Mr. Ericsson for them, and others, that the vessels would sink the moment they got in the water." A conference

the next day among Fox, Secor, Stimers, and Lenthall resulted in a verbal stop-work order to the Secors, whose ships were the farthest advanced, to give time to sort out the problem. Although none of the participants appears to have recorded the date this meeting took place, it was probably very late October, since when Loring arrived in Cincinnati in early November, he told the contractors "that large changes were to be made, but what they had not yet decided."[26]

The accumulation of unmeasured changes—changes made piecemeal, with no quantitative assessment of their impact—nearly sank the harbor and river monitor program as well as the individual vessels. Fox and Stimers, driven by wartime urgency, wanted desperately to speed up monitor procurement as well as to make technical improvements. Stimers tried to do both by accelerating the design process. Under pressure from Fox, he cut corners by modifying the earlier Passaic-class design without making the calculations required to ground the modified design firmly in physical reality. In defense of Stimers, in those pre-computer days, such calculations involved massive manual computational effort—the theories of static stability, of buoyancy, and of balancing floating weights were well understood, but their practical application was extremely laborious. In designs as tight as Ericsson's, however, there was simply no margin for massive changes. In terms of making the calculations, the effort was, "pay me now or pay me later."

It was not until December 15 that Stimers reported that the computational work was complete.[27] He had balanced the ship by moving the turret forward, but he had a tougher problem: "With regard to the draft of water and displacement, we are utterly swallowed up by calculations." A discussion then began about what to do. Ericsson recommended lightening the ships by removing the second inch of deck armor and reverting to pine for the wooden backing of the armor. Stimers insisted on the oak armor backing, but even so, "there is no choice, one inch is all the iron we can have." Fox, for whom even two inches of deck armor was insufficient, would not permit this. "Your proper course is to make these vessels deeper," he wrote Stimers.[28]

Perhaps unconsciously showing that he valued technical improvement over other considerations, Stimers promptly complied. He and Ericsson agreed upon a plan to deepen the vessels 18 inches, increasing their draft to 12 1/2 feet and reducing their speed to 10 knots. Stimers sent

Fox a list of other improvements, including the opportunity to increase the height of the boilers to reduce foaming. Complimenting Fox for insisting on a 2-inch deck, Stimers put the best face on the situation: "You may therefore congratulate yourself that you have caused these vessels to be greatly improved in all their weak points."[29]

On December 22, 1862, Stimers wrote to each contractor outlining the forthcoming changes. Reiterating that the ships were "in their general plan, simply a modification of the Passaic class," Stimers noted that weight-increasing changes had been incorporated until, "Captain Ericsson gave notice that he would no longer be responsible for the floatative power of these vessels." Stimers had "caused the displacement and the weights to be carefully calculated," including the weights needed to balance the vessel without ballast, and as a result "it has been determined to make the following alterations." In contrast to the rest of the letter, written in Stimers's usual direct style, the paragraph that described what had happened to Ericsson's design was written in the bureaucratic passive: "there was added" another inch of iron, pine "was changed" to oak, full thickness "was demanded" for armor plates, boiler weight "was increased" 15 percent.[30] A major engineering blunder, albeit one engendered by a sincere desire for improved ships and by the driving urgency of the war, was being disowned as gently as possible.

In this context, one must ask what had happened to the Bureau of Construction and Repair and the Bureau of Steam Engineering. Construction and Repair let the contracts for all shipbuilding, including that of the monitors, and the chief constructor, Lenthall, was a man of long experience. Why didn't Lenthall review the design and verify that it would float? If he questioned its mechanical feasibility, why did he not discuss the matter with Engineer-in-Chief Isherwood?

One answer is that Lenthall was simply not aware of the changes. From the Passaic class on, the characteristics of each monitor, and the changes to them, came from the Fox-Ericsson-Stimers triumvirate.[31] Lenthall merely issued the contracts; sometimes he did so without even having seen the specifications that accompanied them.[32]

More important, Lenthall and Isherwood had tried to exercise oversight of the monitor program and had been slapped down. In June 1862, they reviewed Ericsson's design for a large monitor. Despite Isherwood's objection that the speed would be far short of Ericsson's estimate, Erics-

son received a contract for not one but two large monitors.[33] Five months later, Stimers disagreed with Lenthall over whether *Puritan*'s deck beams should be made of iron (as Ericsson had originally specified and as the contract required) or of wood, as Stimers (and presumably Ericsson) later recommended. Lenthall reminded Stimers that the inspector's function was to see that the materials and workmanship were proper rather than to redesign the ship. Stimers complained to Fox about this "rude" letter, threatening to report Lenthall "for committing a falsehood in an official dispatch and for having presumed to reprimand me."[34] *Puritan* received wooden beams, showing the degree to which the bureau chiefs had lost control over the monitor program.

In point of fact, they had never had control. When the Navy built the first three ironclads, the officer in charge was Joseph Smith, chief of the Bureau of Yards and Docks. Isherwood and Lenthall made a valiant effort to get back into the game with the "Bureau" ironclad design, but despite its technical merit, the *Monitor* had eclipsed it. By the end of 1862, the bureaus found themselves responsible for the later riverine vessels and the contractor-built seagoing ironclad *Dunderberg*, which was not a monitor, and the Miantonomoh class of "seagoing" monitors, being built in Navy yards.[35] Even the Navy yards were not the bureaus' private preserve, because Stimers's office had charge of the turrets for the ships being built there. Monitors dominated Union ironclad building, and bureaucratically, Stimers's New York "monitor bureau" dominated the monitor program.

Certainly Isherwood's and Lenthall's support for their own "Bureau" design and other substitutes for the monitor, and Isherwood's longstanding mutual antagonism with Ericsson, were elements in their being shunted aside. The most important factor, however, was that Lenthall and Isherwood had lost the battle of perception. Fox was an enthusiast, "a live man, whose services we cannot well dispense with." Another correspondent wrote, "Now Captain you are regarded as the active man of the Dept. and that anything requiring quick movement & prompt action must come through you." Fox perceived a similar drive and enthusiasm in the single-purpose New York monitor bureau, characteristics that were missing from the slower rhythms of the Washington bureaucracy.

Even Admiral Gregory, although not entirely comfortable with Stimers's position vis-à-vis the Navy Department, and over 70 years old him-

self, referred to Lenthall as a "patriarch." When Lenthall and Smith visited New York, he told Fox, "You had better send them oftener, if only to keep them awake."[36] Coupled with Fox's conviction that Ericsson was a genius who could solve any mechanical problem, his perception of slowness cost Lenthall and Isherwood the assistant secretary's confidence, at least when it came to ironclads.

Stimers's situation thus resembled that faced by General Bernard Schreiver in building the first U.S. intercontinental ballistic missile (ICBM) in the 1950s, or that faced by Vice Admiral William F. Raborn in the Polaris Fleet Ballistic Missile project of the late 1950s and early 1960s. Finding that "establishing an organization capable of transcending a cumbersome government bureaucracy . . . presented a challenge as great as, or even greater than, the technical ones," Schreiver realized that he had to "manage 'outside the system.' " Like Schreiver and Raborn, Stimers used the high national priority of his project to bypass a multilayered chain of command and gain direct access to top decision-makers. Unlike Schreiver and Raborn, whose status as heads of their projects was institutionally established and officially recognized, Stimers depended solely upon his personal contact with Fox to get outside the system of "persons who could say 'no' but not 'yes.' "[37]

Many similarities appear between the monitor program and the Polaris program. Like Stimers's General Inspectorate, Raborn's Special Projects Office was responsible for a particular organizational purpose—development of a single weapons system—as opposed to the functionally specialized organization of the Navy Department's bureaus. Like the Inspectorate, Special Projects had to push technological development while integrating advances in many areas to produce a successful weapons system. Each had to differentiate itself from competing organizations, gain and maintain powerful sponsorship, and achieve autonomy by fostering a perception of technical and managerial competence.

However much it might have helped to differentiate them from the General Inspectorate, the bureau chiefs did not deserve Fox's perception of lethargy. Lenthall and Isherwood were jointly responsible for the largest, most compressed shipbuilding and conversion program up to that time and had many calls upon their time and resources. Their development of the "Bureau" ironclad design and their repeated attempts to gain approval for seagoing ironclads show that they were by no means

fossils, inimical to technological change and resistant to progress. In fact, they began the war with a sailing navy that contained a few steamers and built a technologically up-to-date steam navy that had some leftover sailing ships. Yet the breadth of their responsibilities, as much as any bureaucratic foot-dragging, made them appear slow—they could not ignore their other obligations to concentrate solely on ironclads, while Stimers's much narrower organization could respond more quickly to Fox's concerns.

Welles later wrote that he had confided in Fox, who was giving these vessels special attention.[38] Fox reciprocated the secretary's confidence and understood very well both the authority and responsibility it conferred on him. In December 1862, he told Ericsson, "Being myself responsible that some twenty [monitors] are now underway. . . . I have personally considerable at stake in the matter." The stake, he wrote, was his reputation: "It is briefly whether I shall be considered an Ass or a very sensible man."[39] Under such stress, Fox confided not in the bureaus but in Ericsson and Stimers and the highly focused and responsive organization Stimers had built so rapidly. After Fox displayed this confidence by overriding or marginalizing Isherwood and Lenthall, the bureau chiefs appear to have reached two conclusions, both of which impelled them toward a hands-off policy of ignoring the monitors. One was that they had plenty to do in other areas, so there was no point in increasing their workload by trying to oversee the monitors, especially if their opinions were to be ignored. The other was that since Stimers wanted the rewards of independence, he could have the responsibilities as well—he was on his own.

One area in which Stimers was on his own was in fixing the problems of the Tippecanoe class. Had Fox been willing to accept the thinner deck that Ericsson and Stimers recommended, the task would have been relatively simple. The turret would still have been moved, to balance the ships fore and aft, but since none of the ships would be ready for their turrets or turret foundations for some time, relatively little disruption would occur. Other changes would have been minimal, without much need to undo work already done. The course that Fox directed and that Ericsson and Stimers so promptly implemented would produce more capable ships, but it would also delay them far longer than the less extensive work the two engineers first proposed.[40]

The impact of these major modifications was greatest and most clearly felt for the Secors, who had three ships under construction. The *Mahopac, Tecumseh,* and *Mannahata* (later *Manhattan*) were the farthest along of the class; at the time the problem surfaced, Charles Secor recalled, the angle-iron frames were almost complete. Two-thirds of the *Tecumseh*'s plates had been installed, and about one-third each on the other ships.[41] In isolation, it may not seem difficult to add a strake of hull plating, but each of the ribs designed to support that plating had to be lengthened to accommodate the increased height (Fig. 4.2). The stem and sternpost, each an expensive forging, had to be pieced out or remade. Deepening the ships involved extensive work, much of which had to be done on site with hand tools rather than with power tools in the shops. Besides the effort required to redo the work, the changes affected the workers' morale and efficiency. The Secors' superintendent said, "It demoralized the whole establishment . . . it was like building a building and getting it part way done, and the man wants to alter it . . . you have got to discharge a large number of workmen and you don't know what to do."[42]

The Cincinnati ships were not as far along as those in Jersey City, but the redesign still caused significant reworking. Ribs, bulkheads, and stem and sternpost had to be remade, of course, but Swift had to relay the keel blocks for the *Catawba* and *Oneota* as well—adding 18 inches in height to the ships would bring their decks too near the beams of the

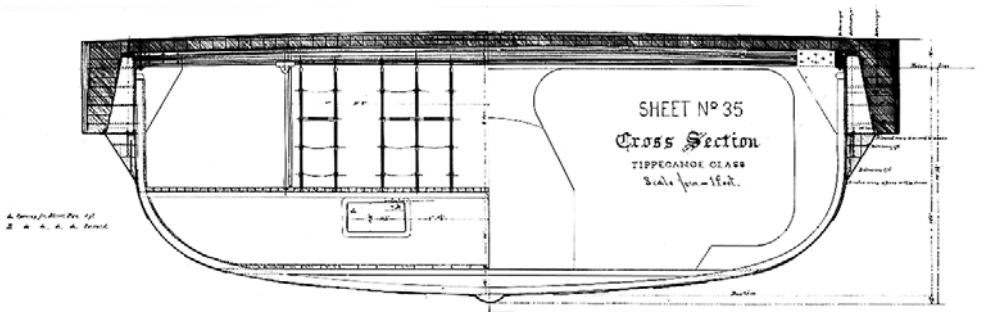


Fig. 4.2. Cross-section of the hull of a Tippecanoe-class monitor. National Archives and Records Administration, Records Group 19, BuShips Plan 7-9-9; Naval Historical Center photograph NH 69060.

shiphouses. The keel plates all had to be removed to relay the blocks, and relaying the keel was like starting the job over. At Greenwood's yard, "everything had to be taken down before you could go to work again. We had to take down the work that was up, have it spliced out, and stem & stern-posts, frames and some other work; the bulkheads had to be cut out, replaced and changed." Loring observed that after receiving Stimers's letter, there was considerable delay in getting the work restarted.[43]

The change cost the builders time in several ways. Most obviously, the government ordered that work be halted until the monitor bureau completed the redesign. The Secors were specifically ordered to stop work, and this may have applied to all contractors.[44] Second, because the Navy did not permit the vessels to go beyond the drawings Stimers sent, "it was therefore impossible for them to go on with anything regarding the original contract when we were contemplating making changes from them." The contractors "couldn't carry on those parts which were not changed beyond what would be permitted in making the changes." Under the older system, the Navy would have told the contractors to deepen the vessels 18 inches and let them be about it. Under the centralized system, the contractors sat idle until drawings could be prepared and duplicated.[45] Finally, the effort Stimers's office made to produce the plans for this major redesign diverted manpower from finishing the drawings for the unchanged parts of the ship.

Although it had not hesitated to incorporate other additions without formally modifying the original contracts, the Navy recognized that a redesign of the magnitude called for in the December 22 letter was far beyond what the contractors could be expected to absorb. Accordingly, Stimers included a paragraph that explicitly described the change process that would be followed; it is worth quoting in full:

> You will please make out a statement in detail, showing the expense to yourselves which will be added to the cost of the vessel, and the length of time which must be added on account of the foregoing enumerated changes. You will please give the local Inspector an opportunity to judge of the correctness of your estimate, that you may both estimate from the same basis. You will understand, of course, that the Government will pay you all expenses incurred on account of these changes in addition to the price agreed upon in the contract, and to allow you the extra time required on account of them to complete the vessels.[46]

On the face of it, this letter (sent to each Tippecanoe-class contractor) showed more sophistication than the clause in the original contract that governed changes. It seemed to recognize that the price of the alterations would vary from shipyard to shipyard, in part because of variations between shipyards but also because the ships themselves were in varying states of completion. The Secors' vessels, which were already partially plated, would require more ripout and reworking than would the ships being built west of the Alleghenies. The letter further recognized that the shipyards were in the best position to estimate their costs, and the requirement that the local government inspector also furnish an estimate implied negotiation over the price. The provision for increasing the contract delivery date by the length of time needed to make the changes explicitly recognized that changes would delay completion.

Yet even with this growing sophistication, Stimers's letter fell short. The changes would in modern parlance be unilateral—Stimers's letter implied negotiation, but it set forth changes that the contractors could not refuse to implement. Had it been a true negotiated change, the government would have obtained a price and schedule impact estimate from the contractor and then decided whether to make the change or to defer or cancel it. In the December 22 letter, the Navy told the contractors to perform the work and only then began to haggle over the price. Obviously, this weakened the Navy's negotiating position, while it encouraged the contractors' hopes that they could use such a major change to make themselves financially whole again.

There would be considerable delay in pricing the change, because neither the contractors nor the inspectors could make valid estimates until they received the revised plans, which would not be forthcoming for some time. There was also some question about what expenses would be included. Both sides agreed that the Navy was liable for the cost of erecting the new work. Beyond that, as when dealing with ripout of the old work, the water grew murky. To complicate matters further, at about this time, the general inspector established a fixed price for alterations based upon the amount of material involved, a fixed price that did not take into account cost differentials among shipyards. Stimers's letter made the Navy's contracting philosophy seem clearer and more sophisticated than it actually proved to be. In so doing, it raised expectations among the contractors that the Navy would be unable to satisfy.

CHAPTER 5

Miserable Failures

Combat Lessons and Political Engineering

The monitors' first significant combat experience came in 1863, revealing some strengths and a number of weaknesses. Their first fleet engagement was Rear Admiral Samuel F. Du Pont's unsuccessful attack on Charleston, and in its aftermath the monitors became a focal point of conflict. The controversy that followed Du Pont's failure colored the monitor program long past the end of the war.

The aggressive orientation of the Union's ironclad program became evident soon after the Battle of Hampton Roads in 1862. In the first of many plans to use ironclads offensively, the Navy decided to attack the forts guarding the entrance to the Cape Fear River to close the blockade-running port of Wilmington, North Carolina. The Navy Department planned an attack in early 1862 but canceled it in mid May, although Rear Admiral Louis M. Goldsborough asserted confidently that he could take the forts there as soon as he could get the ships.[1]

Goldsborough's plan required no Army cooperation, a positive factor in light of General George B. McClellan's involvement on the Virginia Peninsula. The Peninsular Campaign, however, caused Goldsborough's attack on Wilmington to be postponed. Not only did it prevent the Army from providing assistance to the Navy, but McClellan's demands for naval support kept the only two Federal ironclads as yet completed (the *Monitor* and *Galena*) in the James River. McClellan's withdrawal after the Seven Days battles eased this requirement, but Confederate fire at Drewry's Bluff in the James River seriously damaged the *Galena* and again postponed Goldsborough's operation.[2]

The postponement ultimately precluded action against Wilmington. Fox and Welles were in any case already leaning toward an attack on

Charleston. Although it had little strategic importance other than as a blockade-running port, Charleston was the "seat of the great wickedness that has befallen our country." The "insolent, conceited, unreasonable, and arbitrary author of all our national troubles" made an obvious target. In early June 1862, Fox wrote, "the fall of Charleston is the fall of Satan's Kingdom."[3]

Du Pont, the man whom Fox and Welles selected to take Charleston, had earned his admiral's stars by his successful attack on Port Royal, South Carolina, in October 1861. In 1862, he had been impressed with the new ironclads, writing, "I wish now I was forty again, instead of fifty-eight, to go in for ironclads." Du Pont came north for consultation in October 1862 and visited all three first-generation ironclads. He characterized the *New Ironsides* as "one of the wonders of the world, for she is a *seagoing* plated ship. . . . the most formidable ship I have seen," but the *Monitor* was, "scow-like, with decks and turrets laid on." The new monitors, he wrote, would be very superior, and enough of them, armed with Dahlgren's new 15-inch gun, would tear away the walls of forts.[4]

As he grew more familiar with the ironclads, however, Du Pont's enthusiasm began to wane. His correspondence with Captain Percival Drayton, the prospective commanding officer of the *Passaic,* negatively influenced his view of the new monitors, and the difficulties the *Passaic* encountered on her first voyage certainly did not help matters. On that trip, the stays in the *Passaic*'s boilers gave way, requiring her to be towed to Washington, for repairs. The cause of the accident was a matter of dispute; Stimers asserted that the engineers on watch had overpressurized the boilers through carelessness, while Drayton blamed bad work and undersized fastenings. Ericsson furnished men to repair the boilers and enlarge the stays, while Welles directed Gregory to ensure that other ships of the class were properly built.[5]

The delays involved in delivering the ships also influenced Du Pont. All nine Passaic-class ships were to have been completed by the end of August, but all were considerably delayed. Ericsson delivered the first of the class, the *Passaic,* to the Navy on November 25, 1862, but her boiler failure postponed her arrival in Du Pont's South Atlantic Blockading Squadron. This was unfortunate, since in the autumn of 1862, Du Pont's immediate concern was not attacking Charleston but protecting his wooden blockaders from Confederate ironclads. He wrote Welles in late

October that reliable information placed three ironclads building at Savannah and two at Charleston and asked for *New Ironsides* and *Passaic* to be assigned to his squadron. He continued unsuccessfully to press his case, writing later that he had been promised the *New Ironsides* but did not get her because "Fox don't [*sic*] believe a word" about the ironclad threat.[6]

By January 1863, however, things began to come together for Du Pont. The Navy Department's fears for Hampton Roads had eased to the point where the *New Ironsides* was sent to Port Royal, arriving there on January 17, 1863. She entered the harbor the next day, causing Du Pont to report, "I felt my heart lighter." Du Pont was even happier when the monitor *Montauk* arrived on January 19, and one of the *New Ironsides*'s officers reported, "The Admiral is in high glee because he has two iron clads to work with." Du Pont would soon have more than two, but his doubts about the monitors were not assuaged by seeing the *Montauk*'s deck level with the water, her crew "huddled together under the lee of the turret look[ing] like drowned rats."[7] While the *New Ironsides* prepared for action, Du Pont considered what to do about the monitors.

The first thing he did was to write to Welles, saying that the Navy Department should send more ironclads. The next thing, he decided, would be to try the *Montauk* under fire, but with an easier target than heavily fortified Charleston. The Confederate blockade-runner-cum-raider *Nashville* had been sheltered in the Ogeechee River in Georgia for several months, protected by a small earthwork called Fort McAllister. Du Pont sent John Worden (who had commanded the original *Monitor* at Hampton Roads) in the *Montauk* up the Ogeechee to try to destroy the fort and the *Nashville*.

Four hours of firing on January 27, 1863, had no apparent result on either side. Several hits did the *Montauk* very little damage, but she failed to damage the fort either. Du Pont assessed the relatively long-range action as speaking well for the monitor's defensive prowess, but decried her lack of offensive ability. It increased his concerns about attacking Charleston. "If one ironclad cannot take eight guns, how are five to take 147 guns in Charleston harbor?" he asked in a letter to a friend.[8]

Du Pont lost no time in advising Welles of his experiment and its results. It confirmed his opinion that the monitors had no "corresponding powers of aggression or destructiveness" to match their impenetrability.

"In all such operations to secure success troops are necessary," he insisted. This letter crossed Welles's reply to Du Pont's missive of January 24, in which the secretary advised Du Pont, "The Department does not desire to urge an attack upon Charleston with inadequate means, and if after careful examination you deem the number of ironclads insufficient to render the capture of that port reasonably certain, it must be abandoned." Welles reminded his admiral that he already had five of the six ironclads available on the Atlantic coast. The decision would be up to Du Pont, but the capture of Charleston was "imperative," and "the Department will share the responsibility" if Du Pont decided to make the attempt.[9]

Meanwhile, Worden replenished his ammunition for another go at Fort McAllister. On February 1, 1863, he took position about 600 yards below the fort, which the *Montauk* and four wooden gunboats shelled for an hour and fifteen minutes. Fearing his ship would ground on the falling tide, Worden dropped downriver some 800 yards and continued firing for three more hours. Again, there was little effect; the *Montauk*'s projectiles tore up the earthen parapets but did minimal damage to the Confederate guns. At this closer range, the monitor received more damage, including sprung plating and broken armor bolts. The Confederates hailed a victory, claiming that the "gallant and determined" garrison had driven off their armored enemy.[10]

The *Montauk*'s two bombardments brought to the forefront the issue of the obstructions the Confederates had placed in the river to prevent Union ships from running past Fort McAllister. Du Pont perceived that such obstructions, which Confederate defenders under General Pierre G. T. Beauregard had similarly planted in Charleston harbor, would be the most serious impediment to attacking that city. Removing the obstructions under Confederate fire would be very difficult and time-consuming.

Ericsson had considered the problem, proposing in September 1862 to remove obstructions "in the harbor of a certain Southern city" using a raft pushed by a monitor. The raft would carry an explosive charge on its bow to blow up the obstructions. Fox immediately ordered four rafts and thirty charges to be built under Stimers's supervision, and the steamer *Ericsson* took the rafts and "shells" to Port Royal in late January.[11]

It was at this time that Du Pont's fears of an attack by Confederate ironclads were realized. During the night of January 30, 1863, the ironclads CSS *Chicora* and CSS *Palmetto State* got under way, crossing Charleston

bar soon after 4:00 A.M. on January 31 to attack the blockaders. In the melee, the Union steamer *Mercedita* surrendered to the *Palmetto State,* and the USS *Keystone State* yielded to the *Chicora.* Other Union ships withdrew. Both the *Mercedita* and the *Keystone State* escaped, however, when the Confederates failed to board and secure them. The Confederates returned to harbor and the Union ships resumed their stations. Beauregard, trying to apply international law to the Confederacy's advantage, asserted that the blockade had been broken, but despite his protests, it continued as before. Du Pont sent the *New Ironsides* to protect the blockading fleet. Unlike the monitors, he wrote, the *New Ironsides* could at least keep the sea.[12]

Meanwhile, the sense of urgency in the general inspector's office had not been lessened by the passage of Secretary Welles's mid-November deadline. The Navy continued to apply great pressure to the contractors, and as each monitor was completed, she was packed off to join Du Pont's slowly growing force. After the *Montauk* came the *Passaic,* on January 21, 1863, and then the *Weehawken,* on February 5, 1863.

The *Weehawken* had a noteworthy voyage, running into a severe storm en route to Hampton Roads, little more than a month after the original *Monitor* had foundered in a storm off Cape Hatteras. Welles and Fox feared for the *Weehawken*'s safety, but she rode out the gale handily and impressed her commander, John Rodgers, with her performance. Fox promptly circulated Rodgers's report of the trip to bolster the monitors' reputation.[13] On arriving at Port Royal, however, the *Weehawken* forced the Navy to face the problem of keeping such complex machinery operational far from northern bases.

The difficulty stemmed from a failure of shipyard quality control: the bolts that held the inner cylinder head of the *Weehawken*'s port engine had been improperly installed. During the trip, the bolts had worked loose, and as the ship prepared to enter Port Royal on February 5, 1863, the piston drove the loose bolts into the inner cylinder head, cracking it. Pieces of the cylinder head jammed the piston, which promptly cracked the cylinder and broke itself in the process. The *Weehawken* would be out of commission until the cylinder and piston could be replaced, a job that required cutting a hole through the armored deck over the engine room. Either the ship would have to be towed back north for repair or she would have to be fixed in Port Royal.[14]

The Navy Department decided to repair the ship on station and immediately began to marshal the equipment, parts, and talent needed to do so. Fortunately, the Navy already had facilities at Port Royal, where Du Pont had established floating shops to repair his blockaders.[15] Parts could have been a much more difficult matter, since main cylinders and pistons were not "off the shelf" items. For most engines, the Navy would have had to order new parts from the manufacturer, and even with the foundry patterns in hand, it would take weeks to cast and machine a new cylinder and piston. Unlike most engines, however, the *Weehawken*'s was not unique: the Passaics and their engines were all built to the same design, and the Secors, who had built *Weehawken,* were also building the *Camanche*. A few weeks delay would not seriously affect the latter, destined as she was for the West Coast, so on February 13, Welles directed that the needed parts be taken from *Camanche* and sent south. Supervisor Edward Faron and six machinists would accompany them. So would General Inspector Stimers.[16]

Stimers and the others were at work in Port Royal by the last week in February. Their visit was opportune, since it gave Stimers the chance to see firsthand the result of combat in the new monitors. Late on February 27, 1863, the *Montauk* found the Confederate steamer *Nashville* aground near Fort McAllister. The next morning, February 28, 1863, the monitor shelled the *Nashville* until she caught fire and blew up. Again, Fort McAllister's guns did little damage to the *Montauk,* but as she withdrew from action, she struck a torpedo (what we would call a mine) that the Confederates had planted in the river. The damage was minor, confined to bent bottom plating and a broken overboard pipe, but the incident heightened Du Pont's concern about torpedoes.

The explosion also highlighted design deficiencies in the monitors. For one thing, men could not escape quickly from the machinery spaces in an emergency. For another, the pipe elbow that broke was made of brittle cast iron, and it had no valve at the skin of the ship to stop the flooding that would occur if the casting failed. Stimers recommended beaching the *Montauk* to repair the bottom and replacing the cast-iron pipe with a wrought-iron one.[17]

Du Pont, meanwhile, was active on two fronts. Fox told Du Pont on February 20 that the Navy was pushing the work on the monitor *Catskill* based on a report from an Army general that Du Pont would be satisfied

with two more monitors. Du Pont replied on March 2, seeking to "undeceive" the assistant secretary: "the limit of my wants in the way of ironclads is the capacity of the Department to supply them." Simultaneously with this attempt to increase the size of his force, the admiral sent the *Passaic, Patapsco,* and *Nahant* to test their power against Fort McAllister.[18]

Stimers shipped in the *Passaic* during the eight-hour action, in which the ironclad suffered heavy blows but no serious casualties. He came away with a changed impression of the monitors' offensive ability. "Four *Monitors* will do up Charleston without difficulty," he had earlier told Fox, but he now wired Welles: "We must have more guns to be successful against Charleston." Du Pont, who felt confirmed in his opinion of the monitors' offensive deficiencies, was exceptionally pleased that Stimers had come to the same conclusion. The engineer was very clever, Du Pont wrote, but his conversion was "one of those experiences which could only come from actual observation." Du Pont was sure that Stimers, whom he called "Ericsson's high priest," would enlighten the Navy Department more than fifty letters from himself, because Stimers had been a monitor enthusiast "and, like Fox, thought *one* [monitor] could take Charleston."[19]

Both the Navy Department and the general inspector did their best to give Du Pont every possible ironclad and to improve those he already had. In addition to pressing the work upon the remaining Passaic-class ships even harder, Stimers returned north with several other projects in hand. He planned to reinforce the monitors' decks with a layer of wood and more iron plating, since a mortar shell had broken the *Passaic*'s deck and nearly penetrated the ship.[20] He also addressed Du Pont's concern about torpedoes by adding a grapnel arrangement, devised by Ericsson, to the obstruction-clearing raft. The *Nahant* needed a part to repair her 150-pounder rifle, and all the monitors wanted the sort of jointed rammers and sponges that the *Patapsco* had received. The timing of Stimers's dispatches shows his vigor: after arriving at Hampton Roads late in the afternoon of March 11, he wrote from Baltimore on March 12 that he had already arranged to purchase and prefabricate iron for the deck reinforcements of the monitors.[21] Other work at the New York office, notably the design and contracting of the light-draft monitors, had been delayed by Stimers's absence.

Du Pont chafed at the slow accumulation of force, but also at Fox's often-declared desire that the capture of Charleston be a purely Navy operation. Fox considered his duties "twofold: first, to beat our southern friends; second, to beat the Army." Success would cover Du Pont, the country, and the Navy with glory, "with the Army as spectators as we arranged it at Port Royal."[22] Welles had written that the ironclads would enable Du Pont to enter Charleston Harbor and demand the city's surrender; Fox reiterated that idea, expressing the hope that Du Pont would carry his flag, "supreme and superb, defiant and disdainful, silent amid the 200 guns, until you arrive at the center of this wicked rebellion." Du Pont, less sanguine, characterized the harbor as "like a porcupine's hide and quills turned outside in and sewed up at one end." He wrote Fox that there was no question that Fox's grand plan would have the desired results, "but, my friend, you have to *get there*."[23]

Du Pont had long argued that joint Army-Navy action was the way to take Charleston. He had hoped that the Army would take advantage of the panic that followed the occupation of Port Royal, but, "Oh those Soldiers I put them nearly on *top* of the house in Charleston, but I did not push them into the windows and they came back." Du Pont continued to recommend a joint attack, and as late as February 1863, newspaper correspondents at Port Royal were reporting that joint action was planned. Since at the same time Welles was telling his diary that the Navy could move independently of the Army, there was clearly a serious lack of communication between the secretary and his commander on the spot.[24] When it became evident that the Army would send no more troops, Du Pont resigned himself to a purely naval attack. His plan resembled Fox's, in that he intended to pass by the city's outer defenses, Fort Moultrie and Fort Sumter, without engaging them (Fig. 5.1). Instead of attacking the city as Fox desired, however, Du Pont planned to destroy Fort Sumter from Rebellion Roads—that is, attacking it from the north and northwest.

The lack of effective communication between Du Pont and Welles provides background to Welles's growing feeling that Du Pont was not the man to take Charleston. Despite being given all but one of the available ironclads, Du Pont continued to demand reinforcements and continued to delay his attack while awaiting them. In February, Welles wrote in his diary that Du Pont "shrinks from responsibility, dreads the conflict he has sought yet is unwilling that any other should undertake it, is afraid

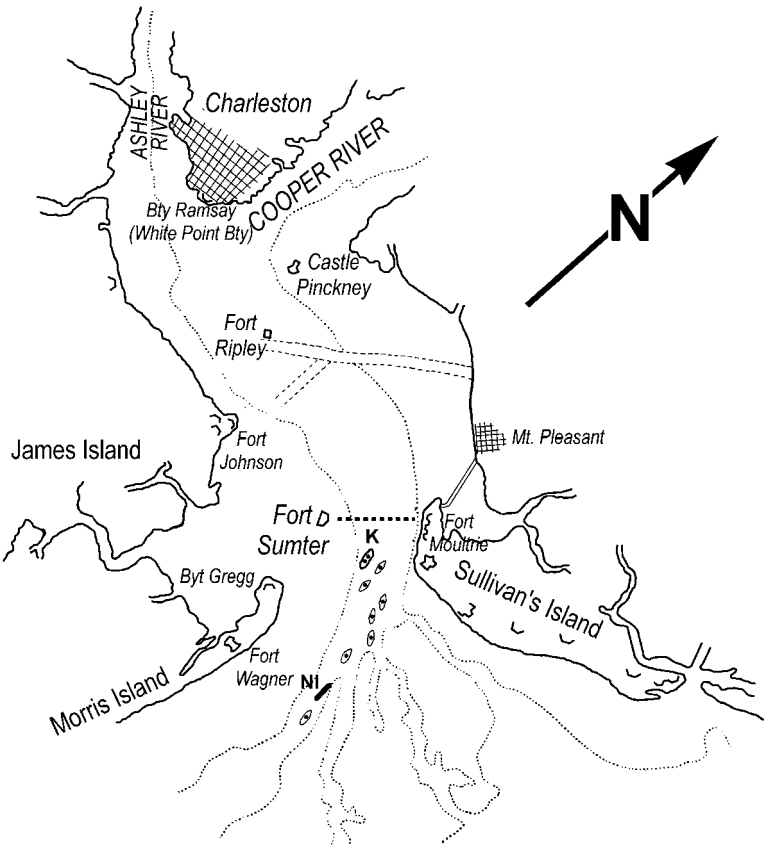


Fig. 5.1. Admiral Samuel F. Du Pont's attack on Charleston. "K" indicates the USS *Keokuk;* "NI" indicates the USS *New Ironsides;* the other ironclads depicted are Passaic-class monitors. From *Official Records of the Union and Confederate Navies in the War of the Rebellion* (Washington, D.C.: GPO, 1894–1922), 14: 81.

the reputation of Du Pont will suffer. . . . I deplore the signs of misgiving and doubt which have recently come over him." By March 1863, Welles was convinced: "Du Pont is getting as prudent as McClellan. . . . He has a reputation to preserve instead of one to make."[25]

Welles's contemporary assessment of Du Pont's motivation is overly harsh, since Du Pont's other correspondence shows that a major element of his caution was his fear that a repulse would do great harm to the Union cause. A second element was his very valid concern that the Confed-

erates would salvage any monitor that might be sunk in the attack, "in which case we lose the whole coast."[26]

Welles later told his diary that although Du Pont had never advised attacking Charleston, he had never discouraged an attack either. Welles's letter of January 31, 1863, had strongly urged an attack, but it left the final decision to Du Pont. Welles and Fox may be faulted for not recognizing Du Pont's distaste for the Charleston plan, but even a sympathetic biographer points out that the admiral never specifically or officially told his superiors that he feared a repulse. In this context, one must consider the tenor of Du Pont's extensive official correspondence with the Navy Department and his private correspondence with Fox: it was assertive, forthright, and direct, with no hesitancy whatsoever about expressing his "growls" on every subject, from force levels to provisions. The diffidence Du Pont showed on the subject of Charleston was uncharacteristic. "If consulted from time to time—if my opinion had been asked—I should have spoken freely," he wrote his wife about his "dampened" hopes.[27] Welles and Fox had every reason, however, to take Du Pont's silence as an indication of satisfaction and his reluctance to move as McClellan-like overcaution rather than prudence.

Stimers arrived back in Port Royal with men and materials on March 25, and immediately took a party up to Du Pont's advanced anchorage on the North Edisto River to work on the four monitors there.[28] Before he left, he told Du Pont about a March 12 meeting that Du Pont characterized as a "scene." Besides Stimers, the impromptu conference had included Welles, Fox, Chase, and Lincoln. Du Pont suspected Stimers of having "*nous a joué faux* [played us false] when he found out how the tide was running," since the sense of the meeting was strongly against further delay. Lincoln wanted Fox to go to Charleston to consult with Du Pont, but as Du Pont wrote, "Fox slided [*sic*] out of it—I wish he had come." Du Pont continued to prepare, writing that Stimers "never explained [to Fox] the work necessary to fit these vessels for action." The monitors, "wonderful as they are," had to be led "as you would help a tottering child."[29]

While Du Pont prepared, so did the Confederate defenders under Beauregard. The attack was no surprise, strategically or tactically, and as Du Pont and Welles both foresaw, the defenses had been strengthened much faster than the fleet. Beauregard had instructed his batteries in detail on how to attack ironclads and there were obstructions scattered

through the channel. Aboard the *New Ironsides,* still on guard at Charleston, Acting Master John M. Butler noted presciently, "At a certain time we had a chance to take a city and it passed—We shall never have it again."[30]

As the attack neared, Du Pont's mood became gloomier. Although he reported himself "very calm and resolute," he filled his letters with pessimism.[31] The monitors assembled at the North Edisto anchorage on April 4 and moved up to Charleston on April 5. The ironclads crossed Charleston bar on April 6 and anchored in the line-ahead formation that Du Pont had ordered, with John Rodgers's *Weehawken* leading and the flagship *New Ironsides* in the middle of the line of monitors. Poor visibility then caused Du Pont to postpone the attack until the next day.

The ships got underway about 1:00 P.M. on April 7, 1863, after a delay caused by the *Weehawken* fouling her anchor in the grapnels of the torpedo-clearing raft she was pushing. Stimers and his mechanics watched anxiously from the Coast Survey schooner *Bibb,* outside Charleston bar. The ironclads moved slowly up the channel, working hard to stem the ebb because the pilots thought it would be easier to see obstructions when the tide was ebbing. At 2:10 P.M., the *Weehawken,* in the lead, encountered a rope obstruction.

The *Weehawken*'s commanding officer, John Rodgers, thought he saw a torpedo explosion nearby.[32] He turned aside before reaching the rope obstruction, throwing the formation behind him into confusion.[33] Confederate batteries began firing at about 3:00 P.M., and Du Pont ordered *Weehawken* to begin at 3:15 P.M. At about 4:30 the admiral signaled his ships to withdraw. By the time both sides ceased firing, the ships had expended 139 rounds and the fortifications 2,229, a telling differential. Four Confederates were killed or mortally wounded, while ten were less seriously injured. The Federals suffered twenty-three casualties, including one mortally wounded.[34] Neither side suffered heavily, and of course, neither was aware of the other's injuries, but the Union retirement made it clear to all that the "great assault" had been repulsed. Torpedoes had played a powerful psychological role, but the physical battle was purely an artillery fight, "other means of defense, obstructions and torpedoes, not having come into play."[35]

With the exception of the *Keokuk,* holed by Confederate fire and sinking, the ironclads returned to anchorage and their commanders reported individually to Du Pont. Their reports convinced Du Pont that renewing

the attack "would have converted a failure into a disaster," since five of the ironclads were "wholly or partially disabled after a brief engagement." At this point, Du Pont and Stimers began to part company. Stimers, wrote one of the *New Ironsides*'s officers, "was then sent for to examine the Monitors, which were found to be pretty well knocked up." The general inspector and his crew went promptly to work, and by the next day, they had repaired much of the damage. Still, Du Pont did not renew the attack, preferring to withdraw the monitors from their "very insecure" anchorage and return to Port Royal.[36]

The press handled Du Pont very roughly. Charles C. Fulton, editor of the *Baltimore American,* wrote a severely critical dispatch, saying: "The great work has been entrusted to incompetent hands." Fulton's article especially angered Du Pont because he believed it had the sanction of the Navy Department.[37] Stimers had returned north on April 11 on the same ship as Fulton, leading Du Pont to believe that he had encouraged Fulton in his opinions.

The repercussions of the repulse eventually cost Du Pont his command, but Stimers and Fox had a more immediate problem: in their first major combat test, the monitors had failed. Confederate fire had jammed their turrets, knocked off the roofs of their pilot houses, bent their port stoppers, misaligned their gun carriages, and killed and injured men by breaking off bolt heads and nuts from the laminated armor. The attack on Charleston had revealed "faults of design which only such experience could point out," Stimers wrote Welles, strengthening the general inspector's perception that defective design was the monitor program's biggest problem. Stimers believed that the faults could be corrected in existing ships and "entirely removed in the new vessels now building."[38]

Stimers arrived in New York on April 14, and by April 18, he had enlisted Ericsson's aid to correct the problems.[39] It is unclear precisely what Stimers considered those problems to be at first, but on April 25, Fox gave Stimers a list of the deficiencies as the assistant secretary saw them. They included:

Lack of ventilation. Fox noted the bad effects upon the crews and pointed out: "It will not do to make a calculation as we did about the first monitor to prove that the men are perfectly comfortable and happy. We must satisfy them now ourselves."

Pilot house weakness. The bolts that held the laminated armor together broke when shot struck the armor. If a heavy shot struck a pilot house near its top, the plating deformed and popped the roof off, leaving the occupants exposed.

High steam pressure required to turn the turret. This was due to the tight clearances between the turret and the deck and the turret and the pilot house. A shot striking the pilot house could slightly bend the long, slim spindle that supported it, causing the edge of the pilot house to dig in and jam the turret (Fig. 5.2).

Weak deck. This was a "fatal defect known from the beginning."

An inadequately protected turret base. Turrets were liable to jam if struck near their bases.[40] If a shot indented the armor near the bottom of the structure, it could jam the mechanism by bulging the bottom of the armor slightly (Fig. 5.3) and causing it to rub the deck below it. Also, a foreign object such as a bolt or projectile fragment could jam between the edge of the turret or pilot house and the horizontal surface under it.

In addition to these problems, there was need for a second anchor; a way for the propeller to cut lines and hawsers; and better viewport visibility.[41]

Stimers and Ericsson set out to remedy the deficiencies. They could correct some of the problems easily. To keep the pilot house roofs from popping off, Ericsson designed an improved pilot house for the later monitors. Existing ships were retrofitted with a new dished roof plate and a 3-inch-thick laminated cylinder. The new roof was put on and the laminated sleeve dropped down over the old pilot house. House and sleeve were then bolted together and the joint between them filled with lead.[42] The sleeve, crimped inward at the top, not only held the roof on but increased the side protection. The deck armor could not be increased overall, as Fox wanted, since the ships could not bear the weight, but extra plating was installed over magazines and engine rooms.

The turret proved to be a tougher problem. Stimers lamented that he could not devise a glacis for the turret base that would not cause more problems than it solved. Ericsson then attacked the problem, but he, too, failed to solve it with a glacis.[43] Ericsson's emotional investment in his

design was part of the difficulty, because it excluded potentially promising solutions. His insistence upon the central support kept him from correcting the bent-spindle problem in future designs, and the "tightness" of his design gave him no room to install a glacis in existing ships. The best he could do was to reduce the chance of base deformation jamming by attaching a thick reinforcing ring of soft iron to the turret at its base (Fig. 5.4). He planned to prevent damage to the gun slides by shortening them and moving them farther away from the turret wall.[44]

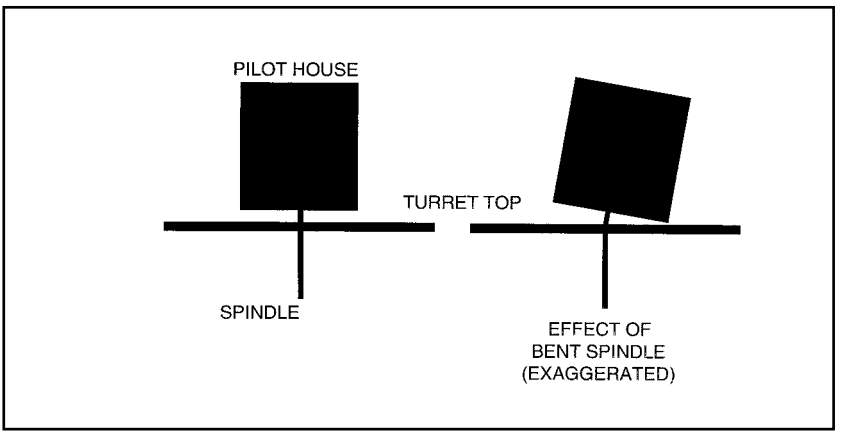


Fig.5.2. Effect of bent spindle (exaggerated).

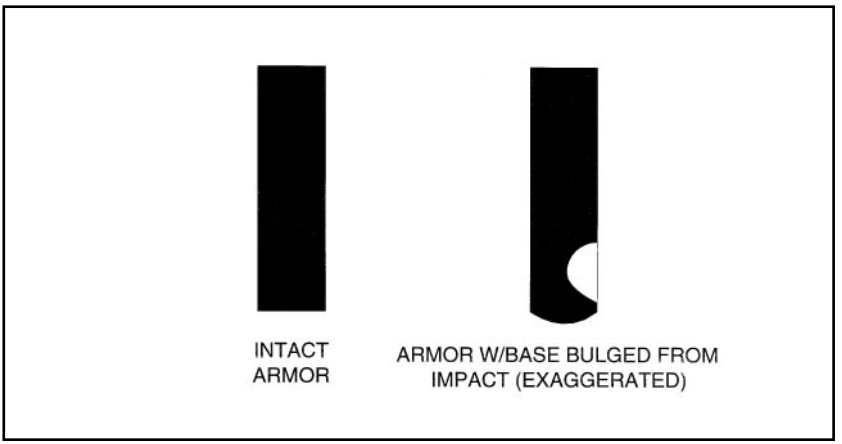


Fig.5.3. Effect of shot on base of turret armor (exaggerated).

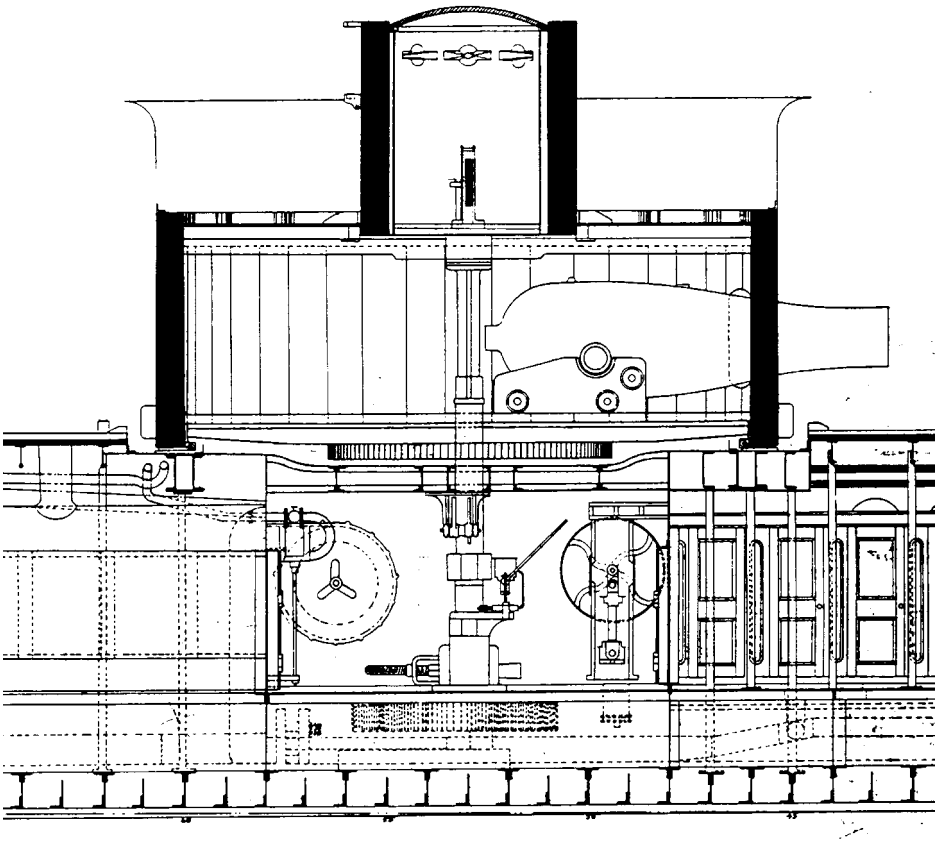


Fig. 5.4. Side view of turret and pilot house of the Passaic-class monitor USS *Montauk*. Note wedge at base of central spindle and reinforcing ring at base of turret armor. This drawing was made in 1896. From National Archives and Records Administration, Record Group 19, BuShips Plan 1-10-28.

In areas where he had invested less pride, Ericsson made significant improvements. Besides the pilot house sleeves and viewports, he simultaneously reduced leakage under the turret and the incidence of foreign-body jamming by redesigning the metal-to-metal seal. In the new system, workmen cut a channel or gutter into the deck and filled it with hemp packing, then covered it with a flat iron ring to form a resilient pressure plate. This helped keep water out while being flexible enough to resist jamming if a bolt head or shell fragment fell under the turret

edge.[45] Yet some problems, such as the danger from broken bolts, could only be ameliorated. Accepting the bolt problem as inherent, monitor crews installed fabric or light iron screens inside turrets and pilot houses to protect the occupants from flying pieces.[46] Ventilation, too, could be improved but not corrected. Some changes simply could not be retrofitted to existing ships without prohibitive expense and time.

The controversy over Du Pont's attack came meanwhile to a boil. Du Pont quickly concluded that the monitors were worthless. On April 8, he wrote that they were "miserable failures where forts are concerned," and his reports blamed the shortcomings of the monitors for the repulse. Welles, concerned about "inspiring the rebels . . . and impairing the confidence of our own men," refused to publish Du Pont's dispatches.[47] Although there was plenty of blame to go around both for the ships and for their employment, in the emotional atmosphere of the war, it was difficult to apportion it fairly. The Navy Department had committed itself publicly and enthusiastically to the monitors, so Du Pont's frontal assault on them was by extension a declaration of war against the Navy Department, and especially against Fox.[48] Ships could not be court-martialed, so to vindicate himself Du Pont laid charges against Stimers.

These charges stemmed from Fulton's article attacking Du Pont, because the latter believed that Stimers had encouraged Fulton with false statements. According to Du Pont, Stimers said the monitors were less damaged than Du Pont claimed, and that Du Pont was too prejudiced against the monitors to give them a fair trial. Du Pont wanted Stimers arrested and sent back to Port Royal for court-martial.[49]

Rear Admiral Gregory informed Stimers of the charges on May 20, and Stimers discussed them in a letter to Fox the same day, telling the assistant secretary that he feared no trial by any court. Welles was not so sanguine. He confided to his diary that Du Pont wanted "to lay his failure [at Charleston] on the ironclads, and with such a court as he would organize, and such witnesses as he has already trained, he would procure Stimers and vessels to be condemned." Welles appointed a court of inquiry instead of the more serious court-martial. "Nothing less will satisfy Du Pont, who wants a victim."[50] The secretary appointed Gregory, Stimers's immediate superior, as president of the court.

The court convened on June 5, 1863, and spent ten days taking testimony. In mid June, it recessed for three weeks to gather answers to

written inquiries, at which time Gregory advised Fox, "*Confidentially* I may say there has not [been] much wickedness brought out." Stimers, he said, was "braced up sharp for the weather gage . . . as stiff as a frozen eel." Stimers complained that the court interfered seriously with his other duties, but Du Pont's case was weak enough that Stimers could describe the inquiry as a dignified farce. After four brief meetings in July, the court recessed again until October. After more testimony and a day of deliberations, the court decided that further proceedings were unnecessary.[51]

Although better than a court-martial, the court of inquiry proceedings had been divisive and disruptive for all concerned. The episode polarized the Navy into pro– and anti–Du Pont factions, which generally coincided, respectively, with anti- and pro-monitor factions. Radical Republican congressmen like Henry Winter Davis used the case to attack Welles (a moderate) and his policies. Moreover, the acrimony and the demands upon Stimers's time adversely affected the entire monitor acquisition program and tinged every subsequent decision made about it with political partisanship.

CHAPTER 6

A Million of Dollars

The Price of "Continuous Improvement"

THE NUMBER of "lessons learned" that the Navy gained from two months' worth of operations and a two-hour general engagement highlighted the unaccustomed problems that the monitors brought in their wakes. Complicating the introduction of the new technology, the monitor program was the first in which the Navy built so many practically identical vessels so rapidly. Just as the Passaics were designed and built before the *Monitor* had had any significant combat experience, so the Tippecanoes (and the light-drafts) were designed before the Passaics entered combat. The testing phase of the variation-selection process vanished under the pressure of the Navy Department's desire to get a substantial force of armored ships as quickly as possible. When the Passaic class began to display its defects, the Navy faced a dilemma. There was no doubt that the monitors required modifications. The question was how to make them.

For the Passaic class, already in service, the Navy had two options: bring the vessels back to the North to be modified or make the modifications on station at Port Royal. In either case, the changes would bear no relation to the original construction contracts. For the ships still being built, the problem was more complex.

The issue boiled down to whether to incorporate the changes before the ships were completed (a system here called "continuous improvement"), or to wait until the ships were finished and then alter them (here called "build it now, change it later"). If the changes were to be made before completion, they had to be made by the building yards; if made after

completion, the work could be performed by the contractors who built the ships, by other contractors, by Navy yards, or by on-station workmen. The magnitude of the changes would affect this decision.

Some changes, like the December 1862 redesign of the Tippecanoe class, clearly were shipyard work and just as clearly had to be done during construction—the redesign involved so much of the vessel's structure that it would be senseless to put it all together and then tear it down and rebuild it. Other items, with less impact, might go either way. When the Navy decided to install centrifugal pumps to improve the monitors' ability to withstand flooding, existing monitors were altered on station, but those not yet completed received their pumps from their builders.[1] Similarly, the builders installed the same sort of turret base rings on the Tippecanoes that the Passaics received in Port Royal. For such alterations, there appeared to be no reason not to implement a "build it now, change it later" program.

To decide where to do the work, Fox needed to know the extent of the alterations. He wanted Ericsson himself to see the results of the battle, but the inventor had often shown his preference for theory and calculation over empiricism and had declined to visit the *Monitor* after the Battle of Hampton Roads when Fox asked him to do so.[2] This time, Fox insisted on firsthand observation. He sent the mountain to Mohammed in the form of the battered *Passaic*, which arrived in New York on May 4, 1863.

Even with Ericsson's input, it took the Navy some time to decide on the repair location; including their efforts before the *Passaic* arrived, Ericsson and Stimers had been preparing for more than six weeks by the time Fox told Stimers that the changes would be made in Port Royal. The Navy could not bring the monitors North, Fox wrote, "as active operations have commenced under new auspices. . . . A gang under a good man should be at Port Royal to attend especially to these matters."[3] This was the genesis of the Port Royal Working Party, the forerunner of today's mobile repair teams and another incremental addition to Stimers's project office.

Stimers had taken a hastily assembled work gang with him to Port Royal to repair the *Weehawken*'s main engine, and he sent another group of two dozen men in early April 1863 to install the deck reinforcements and prepare the monitors to attack Charleston. The April group, re-

cruited by Cornelius Delamater, stayed to help repair the monitors after Du Pont's attack, but it had neither the materials nor the proper trade mix to make the alterations for which the Navy called in May.[4] After Fox's May 27 letter telling Stimers that a gang would be needed in Port Royal, preparations moved into high gear.

At Stimers's behest, Welles had appointed Patrick Hughes as assistant inspector of ironclads on April 18, 1863. Stimers chose Hughes, "one of the greatest drivers I know," to take charge of the working party, and on June 1, directed Hughes to find a steamer to carry himself and about thirty workmen. Besides transporting the men and their tools and materials, the ship would furnish a place for the men to live and bring them back when their work was done, which Stimers estimated would take two months.[5] Hughes located the steamer *Relief,* which was duly chartered, and on June 18, 1863, the Port Royal Working Party, with forty "excellent" men, materials, and $3,400 worth of tools, departed New York. The *Relief* arrived at Hampton Roads on June 19 and at Port Royal on June 25.[6] Hughes and his men immediately began work on three monitors with the limited material they had on hand, while Assistant Inspector Thomas J. Griffin, back in New York, supervised the contractors who were prefabricating alteration materials for the Working Party.[7]

Hughes's men worked hard to install the heavy reinforcing rings on the turrets and perform other modifications, but on July 4, 1863, Hughes was told to put together everything they had taken apart so that the monitors could go to sea on July 8. "We are going into that operation again," Fox had told Stimers a month before; this time, it was under a new leader, who had more faith in ironclads than Du Pont.[8]

Du Pont's correspondence with Welles had grown almost daily more acrimonious since April. Writing bitterly that rumors of his impending relief from command meant "war in favor of the ironclad plunderers, to sustain whom I must be sacrificed," he asserted that the Navy Department had sent "untried machines. . . . all received on Mr. Ericsson's *dictum*" to be tested against "the most thoroughly and scientifically defended place in America." The "clever men" of the monitor interests, however, felt that "Charleston could have been readily taken if naval officers had believed in the irresistible machines in their hands."[9] Whatever the merits of the case, by late May, Du Pont had lost Welles's confidence. He could not remain in such an important command.

Captain John A. Dahlgren had been lobbying for command of the attack on Charleston since October 1862, but Welles refused his requests because Dahlgren's ordnance work was too important to leave and because Dahlgren himself was far too junior for such a position.[10] When Welles decided to remove Du Pont, Dahlgren, by then a rear admiral, immediately renewed his entreaties. Welles instead chose his old schoolmate Rear Admiral Andrew Hull Foote to succeed Du Pont and offered Dahlgren the position of second in command. Dahlgren declined, unwilling to serve as a subordinate, but then accepted when Foote agreed that Dahlgren would lead the attack on Charleston. Foote fell ill in mid June and died on June 26, however, and Welles finally bowed to Lincoln's wishes and appointed Dahlgren. On July 6, 1863, Dahlgren relieved Du Pont as commander of the South Atlantic Blockading Squadron.[11] He lost no time in commencing operations. On July 10, 1863, Brigadier General Quincy A. Gillmore began to besiege Fort Wagner on Morris Island, backed by the guns of Dahlgren's monitors.

The monitors came under fire again on July 11 and 12, 1863, after which they had a few days respite before engaging Fort Wagner on July 18 and 20. In these actions, the still-unmodified monitors suffered the same sorts of damage they had received in Du Pont's attack. On July 21, the *Relief* took Hughes and his men to Charleston, where they began to repair Dahlgren's ironclads. Meantime, Dahlgren wrote to Welles in a tone reminiscent of Du Pont's "limit of my wants" letter, wondering what to do about the monitors. The modification work was, he wrote, "suspended in consequence of the operations now pending. . . . so far from being able to spare one [monitor for repairs], I would rather request more." By July 24, however, he had recognized that some maintenance was essential, listing the monitors *Catskill* and *Nantucket* as under repair. On July 31, Dahlgren advised Stimers that three monitors would be put back in Hughes's hands as soon as they could be spared.[12]

Stimers was ready, although he had to charter a steamer to send over sixty tons of prefabricated modification kit material to Hughes. The material included pilot house sleeves and covers, as well as bronze glacis rings for the bases of the pilot houses and thick iron rings for the turret bases. After the materials arrived, Dahlgren tried to restrict the number of monitors under repair and arbitrarily to limit the time given the mechanics to do their jobs.[13] The small number of available monitors meant

that the loss of a single ship would decrease the already-meager offensive power of the monitor fleet by 20 or 25 percent. The need to balance the loss of availability caused by repairs against the loss of efficiency caused by lack of repairs had been far less acute with wooden sailing ships.

In early August, Gregory told Stimers to alter the monitor *Sangamon* in Hampton Roads "with utmost dispatch." Stimers sent a working party of twenty men under Inspector M. Mara, who completed the *Sangamon*'s modifications on September 22. By October 2, all the Port Royal monitors except the *Nantucket* were finished. In mid September, the intensity of combat at Charleston markedly diminished, and by mid October, monitors were being regularly rotated to Port Royal for repairs and bottom cleaning.[14] By late November, Stimers recommended that the original Port Royal party of forty men be relieved by a new group of twenty, with a trade mix weighted more toward repairs than alterations. Gregory concurred, and about December 4, Griffin and his men of the second Port Royal Working Party departed New York in the chartered steamer *Commander*. Hughes's group left Port Royal for the North aboard the *Relief* on December 23, 1863.[15]

During this time, Stimers continued to direct and support both working parties, dealing with everything from a shortage of bolts to pay disputes with the mechanics working on the *Sangamon*. Simultaneously with altering the monitors in service, he was making similar changes on those under construction. He was providing both original and revised drawings for the Tippecanoe-class and the light-draft (Casco-class) monitors. He was supervising twenty-nine Tippecanoes and Cascos as well as Ericsson's *Dictator* and *Puritan*. He was designing a "fast sloop of war" (which he proposed to call the *Mercury*) and a twin-turreted monitor. To top it off, he was the subject of a court of inquiry. "Stimers cannot properly superintend the 6 vessels and be planning others at the same time," Ericsson had opined over a year before, when Stimers had far fewer vessels to inspect.[16] By the summer of 1863, the general inspector had been working at a killing pace for over eighteen months.

Stimers had been working on the Tippecanoe class when Ericsson expressed his concerns in April 1862, but by the end of that year, Stimers was deeply immersed in the light-draft monitors. Welles had written in 1861 of the difficulty of combining shallow draft with heavy armor, but difficult or not, the Navy needed a shallow-water ironclad. The light-

draft monitor program began in the summer of 1862, when Fox asked Ericsson for an invulnerable ship with a 6-foot draft that could penetrate the rivers of the Confederacy.[17] By early September, Fox was pushing Ericsson and Stimers for a ship with a 4-foot draft, but by the middle of the month, Ericsson had decided that this was impossible. Undeterred, Fox told Stimers that Ericsson should try for a 6-foot draft, saying, "The side that produces the impregnable 6 footer, wins the rivers and waters of the South and West."[18]

Fox entreated Ericsson not to give up, saying that the enemy would "draw himself into his shell," and that light-draft ironclads would be needed to get him out. Fox envisioned an entire fleet of monitors, characterized by their draft: "20 feet for foreign nations; 10 feet for coast defence and harbor work; 6 feet for rivers."[19] On September 29, Ericsson promised to provide the information Fox would need to advertise for the ships, and on October 5, he wrote that he had succeeded in developing a suitable design (Figs. 6.1, 6.2, and 6.3).[20]

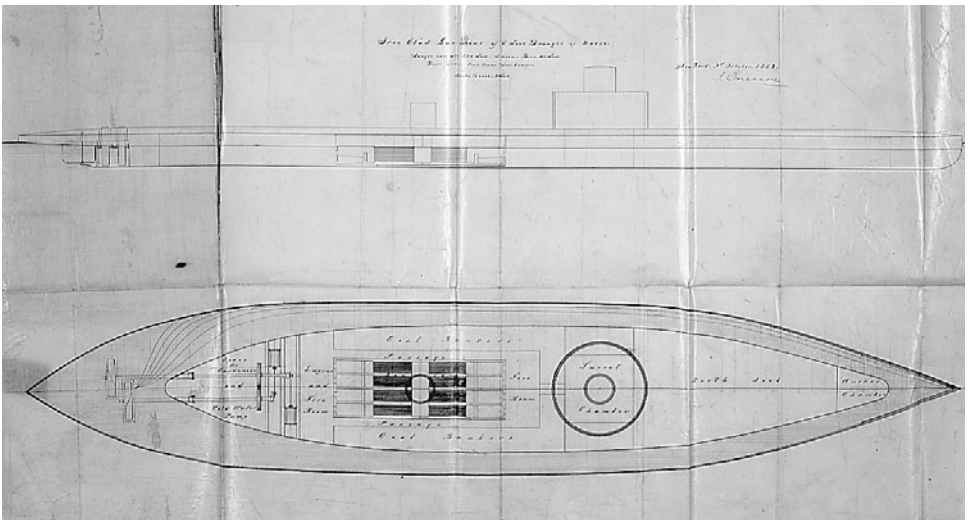


Fig. 6.1. Plan and longitudinal section of Ericsson's design for a light-draft monitor. These previously unpublished plans show the simplicity of Ericsson's conception. The quality of this reproduction is impaired by the heavy creasing caused by years of undisturbed storage. From Ericsson to Welles, February 24, 1863, National Archives and Records Administration, Record Group 45, Entry M124, roll 433, 67.

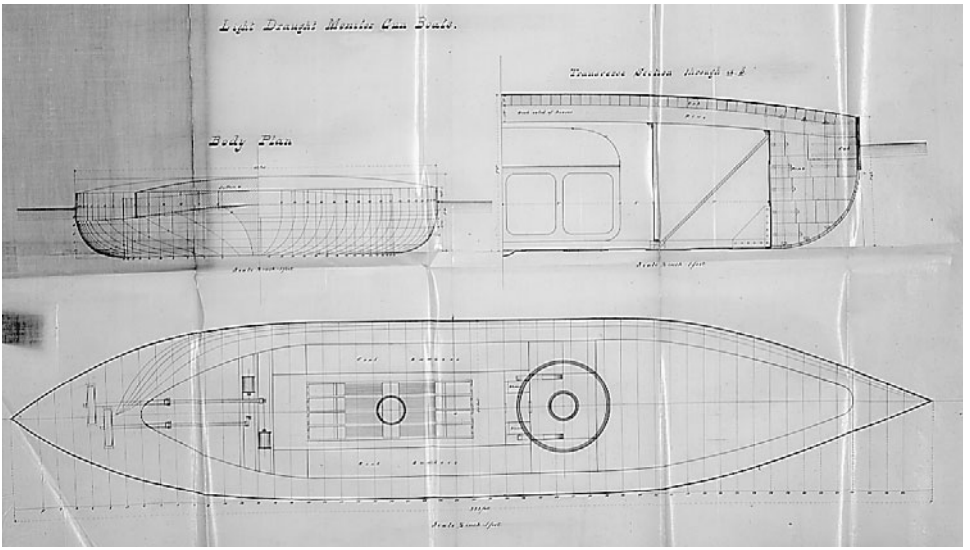


Fig. 6.2. Plan, body plan, and transverse section of Ericsson's design for a light-draft monitor. From Ericsson to Welles, February 24, 1863, National Archives and Records Administration, Record Group 45, Entry M124, roll 433, 67.

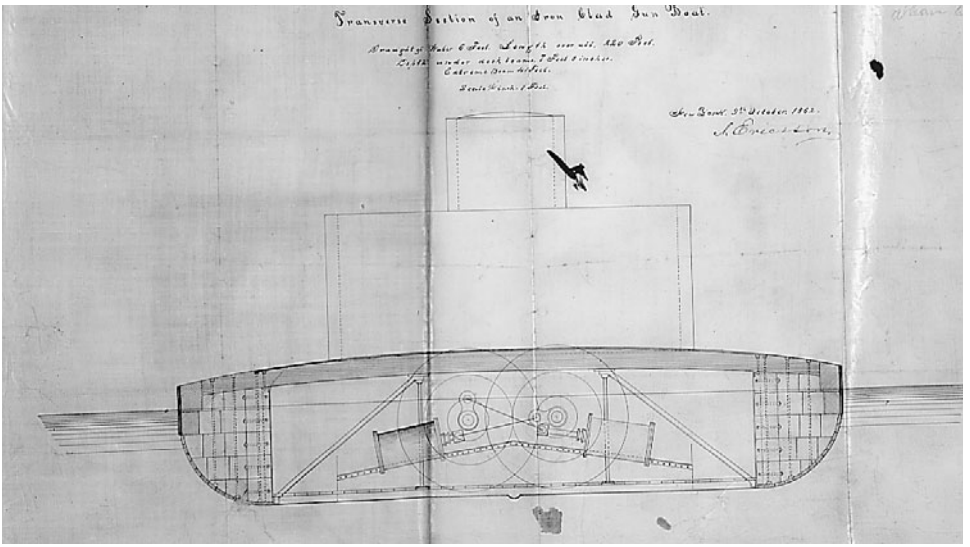


Fig. 6.3. Transverse section through engine room of Ericsson's design for a light-draft monitor. From Ericsson to Welles, February 24, 1863, National Archives and Records Administration, Record Group 45, Entry M124, roll 433, 67.

Ericsson put much thought into his plan, explicitly considering resource availability. He listed the conditions he aimed to meet for Fox, and while the first was that the vessel should be shot- and ram-proof, others showed a keen awareness of the country's industrial position. The vessels were to be as simple as possible to build, both hull and machinery, and they were to minimize the use of iron, "as it cannot be obtained whilst the other Iron Clads are in process of construction." If Delamater's works had not already been full, Ericsson said, he could build three of the vessels there in ninety days. In addition, he told Stimers, he would furnish detailed plans for the ships.[21] At this juncture, the promising program began to go bad.

Ericsson sent his general plans for the "six footer" on October 9, 1862, after which, he later testified, he heard nothing for several months. Meanwhile, the workload Stimers had assumed began to impede progress, since the drawings for the Tippecanoe-class monitors were already late, and Stimers had no draftsmen to assign to the light-draft project. By mid November, only two men could be spared for the "6 foot boats." The third week in November found the light-draft plans not yet ready, and on November 20, foreshadowing more problems, Stimers wrote Fox: "In making the changes required I have had to beat about the bush considerably."[22]

The changes continued to mount. Stimers changed the boilers, the engines, and the machinery, and each change moved the vessels farther from Ericsson's original conception of a quickly built, simple, cheap ship. Eventually, Stimers discovered that with all their additions, the vessels would draw 10 inches too much water, so he "set Engineer Allen at it" to redesign them. The iron hull of the new design was 12 feet longer and 3 feet wider than the original, and the wooden raft surrounding it was 5 feet longer and 4 feet wider. By now, it was December 30, 1862; Stimers had spent over two months making the light-draft vessels larger, more expensive, and more complex.[23]

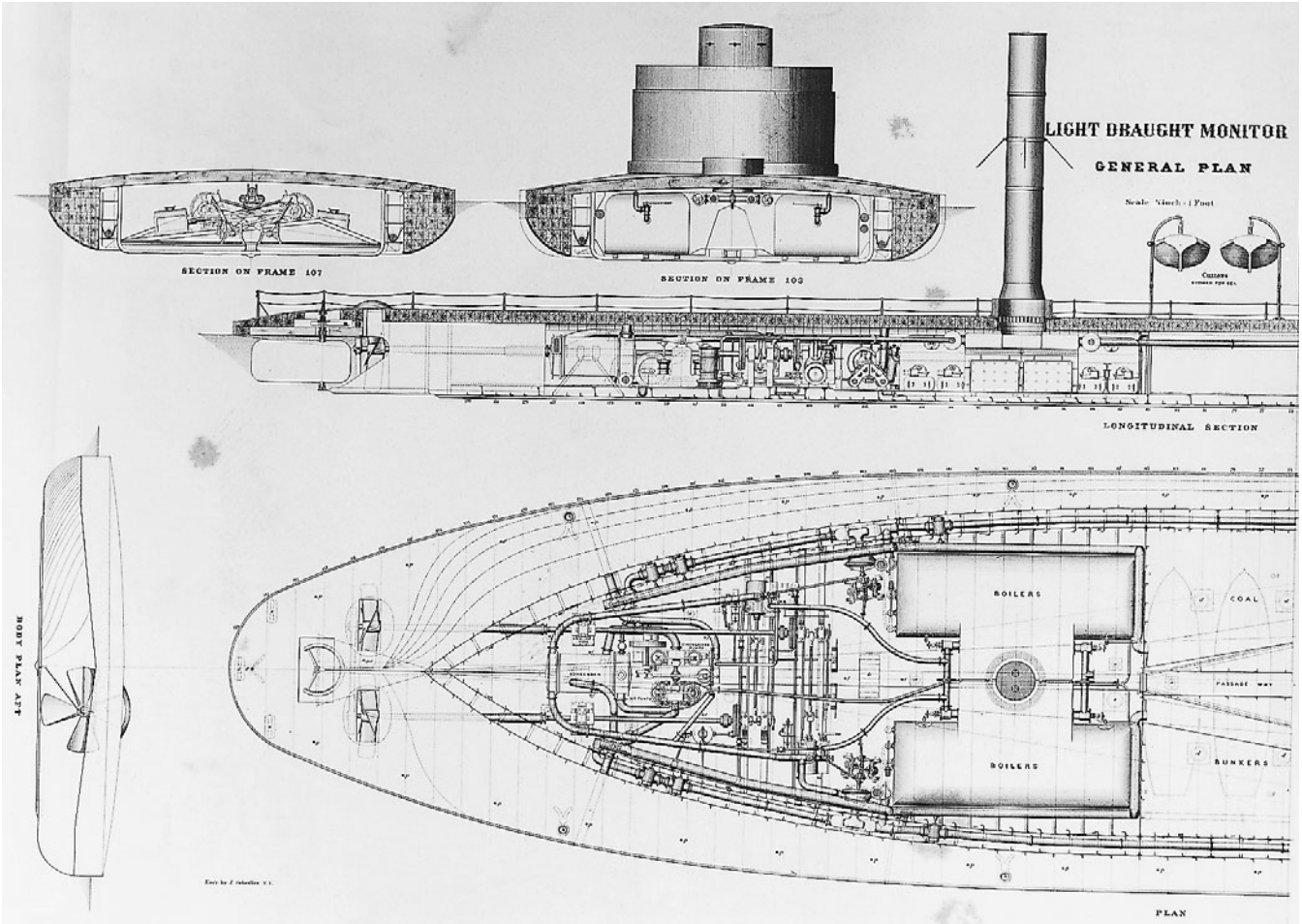
In one critical respect, the light-draft design evolved in the same way as the harbor and river design. Like the harbor and river monitors, the light-drafts began as a relatively simple design. Similarly, too, improvement after improvement was made to them with the best of intentions but without any analysis of the impact. As with the harbor and river monitors, when belated calculations showed the "improved" light-draft

design to be only marginally buoyant, Fox and Stimers chose to enlarge the hulls rather than give up any of the additions. Evidently, Fox and Stimers still considered ironclad technology itself to be the critical factor.

Once Stimers had his redesign in hand, he took the plans to Washington. There, Rear Admiral Smith suggested installing a system of water tanks, piping, and pumps to increase the vessel's draft for battle or decrease it for cruising or for floating free after grounding. All this added further complexity and weight (Fig. 6.4). Not until February 1863 was the design mature enough to advertise for bids, the deadline for which was made February 24, 1863.[24]

In allowing the elaboration of the light-drafts, as with the harbor and river monitors before them, Fox displayed ambivalence about his priorities—which was more important, technical elegance or speed of construction? In each program, he bombarded Stimers and Gregory with very forceful demands for haste, but only after accepting a design that would take far longer to build than the one he had initially approved. Under such intense and constant pressure, one would have expected Stimers to cut corners—to simplify his designs to make them quicker to draw and quicker to build. Instead, he persisted in making them not less but more complex. Fox, no engineer, may not have appreciated how much the search for technical perfection would retard construction. Stimers, however, should have known—why did he encourage Fox's belief that he could have both technical elegance and quick construction? To answer, we must indulge in speculation.

Stimers's professional ambition played a large part in the evolution of the monitor program, but there was in him an element, no less vital, that is more difficult to address. That element is artistic pride—the satisfaction of solving a difficult engineering problem in a way that goes beyond an everyday, workmanlike solution to enter the realm of art. Although he told Fox in April 1862 that he was willing to accept Ericsson's designs and "forego the reputation it would give me to have superior vessels built after my plans," Stimers clearly sought not only professional advancement but also professional recognition. His emphasis on his designs implies that he wanted to be known as a designer as well as an operator, as a man whose designs were elegant, economical, and efficient, as well as effective—whose designs would produce a recognition that this particular solution was *the* one best solution.[25] Welles, an astute observer,


LIGHT DRAUGHT MONITOR
GENERAL PLAN
Scale 16inch = 1 Foot
SECTION ON FRAME 107
SECTION ON FRAME 103
LONGITUDINAL SECTION
BODY PLAN AFT
BOILERS
COAL
PASSAGE WAY
BOILERS
BUNKERS
PLAN

reached a similar conclusion when he noted that Fox and Stimers had shut out Ericsson and the bureau chiefs because they hoped to "acquire reputation."

In this effort, Stimers faced practical difficulties. Leaving aside whether or not Stimers actually could have done "elegant" engineering, the monitor type was inseparably identified with Ericsson. The "Monitor myth" involved the inventor as much as the ship, and there was no room in that myth for another designer of monitors.[26] Even in late 1862, when Ericsson's attention had turned to his two seagoing "big pets," the compression of the variation-selection process left little room for Stimers as a designer.

The *Monitor* was admitted by all to be an experiment, and Ericsson had begun to design an improved version long before the original was launched. This program of "preplanned improvement" helped Ericsson to resist "improving" the original during construction. The Passaics certainly suffered additions and changes during their construction, but during the late spring and early summer of 1862, the Tippecanoe class provided a vehicle for further planned improvement. By autumn 1862, however, the relatively orderly sequence of development (from the *Monitor* to the *Passaic* to the "contract specification" *Tippecanoe*) had been disrupted. The Passaic, Tippecanoe, Dictator, Puritan, and Miantonomoh classes of monitors were under construction simultaneously, and Ericsson was already developing a light-draft design (Fig. 6.5). With so many monitors already in progress, the chances of beginning another batch anytime soon were correspondingly diminished. To attain technical perfection—more precisely, to distinguish his work from Ericsson's—Stimers dared not wait. Instead of accumulating improvements for follow-on monitors that might not be authorized, Stimers had to incorporate them in designs that were already under way.

Facing page

Fig. 6.4. Stimers's plan for the light-draft monitors, showing ballast system and tankage. Even after allowing for Ericsson's design being only preliminary, the increased complexity is noteworthy. From National Archives and Records Administration, Record Group 19, Dash Flat, Plan 139-15-1K.

If professional advancement in the Engineer Corps had been Stimers's sole personal goal, Ericsson's original light-draft design would have provided a perfect vehicle. By concentrating on producing simple, cheap ships and giving Fox the light-draft monitors he craved in 1863, the general inspector could have cemented his reputation as a man who got results. As an additional benefit, building the ships to Ericsson's design would have insulated Stimers from any technical failure. Lacking his intimate correspondence, we cannot know whether the general inspector consciously pursued technical elegance in a quest for professional recognition. That desire for recognition, however, complements Stimers's well-established ambition for professional advancement to explain why he so readily embraced Fox's "continuous improvement" philosophy and why he was the last of the Fox-Ericsson-Stimers triumvirate to recognize that the search for technical perfection was no longer the most salient aspect of the monitor program.

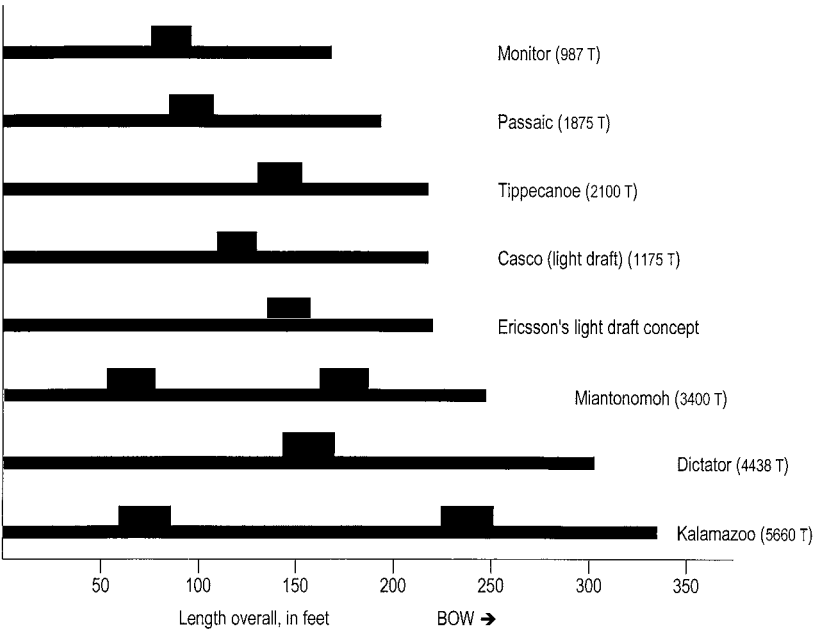


Fig. 6.5. Silhouettes of monitor classes, showing relative sizes of the original *Monitor*, the later monitor classes, including the Passaics, Tippecanoes, and Cascos, and Ericsson's original light-draft monitor concept.

By the time the bids for the light-drafts were to be opened in late February 1863, Stimers had departed for Port Royal. In his absence, Fox wrote Ericsson about the light-drafts. The Navy, Fox said, presumed that Ericsson had furnished the plans and that Stimers had worked out the details to Ericsson's satisfaction. "Before we contract I ought to know that this is so. . . . Before launching off into the construction of these light drafts you will tell me if they are all right as we take them presuming them to be yours." One may imagine that Ericsson's reply caused consternation: Stimers, Ericsson wrote, had "frittered away" the inventor's principles by changes. Moreover, he had persistently withheld the plans, so that Ericsson had not seen them until the day the bids were to be opened.[27]

This episode and the months preceding it do not show Fox in a particularly good light. He "presumed" that Stimers and Ericsson were working together, but he never discussed the light-drafts with both simultaneously in the sort of design conference that would have been worth hundreds of letters. Entering the realm of hypothetical questions, what might have happened if Fox had met face-to-face with Stimers and Ericsson to review the light-draft design? A meeting in October or November 1862 might have constrained Stimers's elaboration of the design; a meeting in December might have redirected Allen's enlargement; a meeting in January 1863 might have scuttled the piping, pumping system, and tanks that added so much weight, cost, and time. Instead, Fox accepted Stimers's repeated assurances that all was well and did not ensure that Ericsson was directly involved.

In fact, all was not well. Victory has a thousand fathers while defeat is an orphan, and it becomes difficult to ascertain from the welter of self-serving statements precisely what happened. Welles later told his diary that Stimers and Fox had "connived that they could do this work independent of the proper officers [Lenthall and Isherwood] and perhaps of Ericsson—probably hoped to acquire reputation." Fox, he wrote, "expected great success . . . Stimers became intoxicated, overloaded with vanity."[28] Stimers and Fox apparently had invested too much in the general inspector's design to reopen the issue (or perhaps it was simply that Stimers's redesigns had taken so long that Fox's need was extremely urgent), but Fox disregarded Ericsson's warning. Instead of delaying the contracts to thrash out the technical issues, Fox evidently prevailed upon

Welles to let the contracts using Stimers's design. This decision was made before Stimers returned from Port Royal in mid March, since the first contracts were awarded on March 2, 1863. By March 17, eight light-drafts were on order, and by June 24, all twenty contracts had been awarded.

In awarding contracts for the light-draft monitors, the Navy was impelled by the twin goals of industrial mobilization and spreading the wealth of patronage. Six of the twenty contracts went to firms that had built or were building other monitors, while the other fourteen went to firms or individuals that had no monitor-building experience.[29]

The new builders ranged from well-equipped machine shops and ironworks to men who had nothing more than a contract and some optimism. In Camden, New Jersey, the Kaighn's Point Iron Works of Willcox & Whiting billed themselves as dealing in "Marine Engines, Corliss' Engines, [and] Boat Repairing." The government inspector assigned to their new ironclad, the *Koka*, called their machine shop "first rate"; they had ordered the tools to convert their small shipyard to build heavy iron hulls, and when those tools arrived, their facilities would "compare favorably with [those of] any new contractors."[30] In Baltimore, A. & W. Denmead & Son branched out from its foundry and machine shop business to build the *Waxsaw* in a new shipyard at Canton, Maryland. Although somewhat shaky at the turn of the decade, the firm did well in the wartime ship repair business and was reported by R. G. Dun & Co. to be "perfectly good" by 1863.[31]

Contractors in the New York metropolitan area also got their share of the light-drafts. Jeronemus Underhill's Dry Dock Iron Works in Greenpoint had facilities to build boilers but had to go outside for machine work, castings, and forgings. Underhill, a "sharp, shrewd businessman," had built the ironclad *Keokuk* as a subcontractor to C. W. Whitney, and once he rented new ground and retrieved his tools from storage, he was fairly well equipped to build the *Modoc*.[32] William Perine, last seen as a partner-in-name in Perine, Secor & Co., leased a shipyard in Williamsburgh, New York, to build the *Naubuc*. Perine's poor credit probably contributed to the slow pace of outfitting his yard, and Stimers described his machinery subcontractor Dolan & Farron as "the poorest workmen and the most difficult party to get along with of any boiler makers of my acquaintance."[33]

Boston's Atlantic Works, a general machine shop, lacked facilities for making boilers, castings, and forgings. Its owner, Aquila Adams, had to set up a shipyard, a boiler shop, and a smithy before he could begin on the *Chimo,* but he did so promptly.[34] In East Boston, Donald McKay, his brother Nathaniel, and George Aldus obtained two contracts, one in Donald's name for the *Nauset* and one for McKay & Aldus for the *Squando.* McKay's shipyard was known for its clipper ships, but as late as July 1863, his new machine shop had neither steam power nor a full complement of tools.[35]

Instead of establishing or expanding their own facilities, some contractors sought to take advantage of the Navy by subcontracting the whole process. George W. Lawrence of Portland, Maine, obtained a contract for the *Wassuc* and promptly sublet the ship to the Globe Works, a machine shop and foundry in Boston, which already had a contract for the *Suncook.* Fox showed how serious the Navy was about distributing the contracts when he threatened to cancel Lawrence's ship, writing, "Lawrence agreed verbally with me to build his light draft in Portland and there she must be built." Lawrence eventually built the ship in Portland. Other subcontracting "deals" were more successful. M. Franklin Merritt, of Stamford, Connecticut, received the contract for the *Cohoes;* he subcontracted the hull to the Continental Iron Works and the machinery to a Newark, New Jersey, firm. George C. Bestor, of Peoria, Illinois, subcontracted the *Shiloh* to Charles W. McCord of St. Louis, where she was built side by side with McCord's own *Etlah.*[36]

The light-draft contracts themselves marked a further evolution of the Navy's system for acquiring ships. Recognizing the problems caused by the backlog in Stimers's drafting room, the contracts stated that the government would furnish general plans and specifications, while the contractors were to make working drawings to meet the specifications and have them approved by the superintendent. Even more significant, the contract provided a specific mechanism for dealing with changes. Explicitly giving the government the right to alter the plans and specifications "at any time during the progress of the work," it also committed the government to compensate the shipbuilder for extra expense and laid down that "in each case the cost of the alterations [is] to be determined when the changes are directed to be made."[37]

The idea that individual contractors would make their own detailed

drawings formed a major part of Ericsson's conception of the light-draft program. Ericsson was the first of the Fox-Stimers-Ericsson triumvirate to perceive that technical perfection was no longer the most crucial issue. Recognizing explicitly that extratechnical factors had taken center stage, the inventor set out to develop a design that would make minimum demands upon the nation's strained resources for building iron ships. His plan had included a very simple metal hull, filled with the simplest possible machinery and surrounded with a wooden raft. This type of construction, which emphasized carpentry, would allow the Navy to take advantage of the sort of widely distributed shop practice that was absent in iron shipbuilding. It would enable traditional builders of wooden ships to contribute to the ironclad program with relatively small outlays of time and money to convert their shipyards. Furthermore, it would ease the burden on the Navy's design teams by obviating the need for very detailed drawings.

The idea would have worked if the ships had remained true to Ericsson's original conception, but the much greater complexity of Stimers's vessel made the make-your-own-drawings approach technically more risky. Stimers's insistence on highly detailed specifications made the approach financially risky as well. One contractor's workmen described the ninety-two pages of small type that made up the "Specification Book" as "the monitor prayer book." Each supervisor "had to have one of these books in his pocket." The complexity of Stimers's vessel combined with his extremely detailed specifications made the light-draft contractors decide to wait for the government's drawings rather than taking the potentially costly risk of making their own and having their efforts rejected. The practical result was that the Navy took charge of making the detailed working drawings and prohibited the contractors from proceeding until they had those detailed drawings. For contractors, acquiescence must have seemed the prudent course.[38]

Fox and Ericsson may not have been aware that Stimers planned to impose such detailed specifications. Fox appears to have approved the wide distribution of contracts with the intent that the vessels and their machinery would be simple enough for many firms to make quickly. Ericsson encouraged Fox when he offered to help "by separating the turret from hull contract. We can save half [the] time as those who can build boats cannot undertake turrets." In addition, Ericsson noted, more con-

tractors would be able to bid: scores of establishments could "build all else but not the vessel."[39] Fox still insisted that speed of construction was his highest priority, and Ericsson saw simplicity and division of labor as the best ways to achieve it.

Others agreed with Ericsson. Boston's Curtis & Tilden told Fox that the ironwork for the light-drafts was simple, while the woodwork was complex. Accordingly, it would be "equally proper for a *shipbuilder* to contract with the Government for such a monitor, getting his ironwork done for him, as for an *Iron-worker* so to contract, employing us to do his woodwork" (emphasis in original). Fox concurred, endorsing the letter, "If the Dept desires many of these vessels there seems to be no objection to this," and Curtis & Tilden received a contract for the light-draft *Shawnee* a few days later.[40] The shipbuilders' need to write such a letter indicates how completely engineering and ironworking firms dominated the ironclad program.

By the time Stimers returned from Charleston in April to add more changes to the ships under construction, the monitor program had almost peaked. Yet there was still a great deal to do, particularly with regard to changes, which came thickly as combat experience mounted. As Stimers later phrased it, "the whole object of having vessels of this kind was to enable people to go into fights that otherwise they would not be able to approach and remain in them and come out whole."[41] Where current designs fell short, changes were necessary.

Charleston-induced changes were applied to monitors under construction as well as to those in service, and the contracts issued for the later light-drafts incorporated many of them.[42] In May 1863, however, few light-drafts had been laid down, and it would be relatively less difficult to change something that was not yet built. For the Tippecanoes, just recovering from the December 22 redesign, it was a different story. An example is the change Stimers called for on June 18, 1863.

Charleston's gunners had tested Du Pont's monitors and found them wanting. Ericsson had used nuts and bolts to join the layers of the monitors' laminated armor, and shot striking the outside broke the bolts. Severed nuts and bolt heads then flew around inside with sufficient velocity to injure or kill crew members. The monitors already in service applied a cheap, simple and effective "field expedient" fix by hanging fabric or sheet metal screens to keep flying bolt heads away from the

crew. For ships under construction, Ericsson and Stimers redesigned the pilot houses and turrets, thickening the armor and replacing the bolts with special rivets (Fig. 6.6). Unfortunately, the turrets and pilot houses for the eastern-built Tippecanoes were nearly finished, so they had to be dismantled, modified, and rebuilt. The change, and an accompanying modification that required replacement of all the deck armor, involved major reworking, at immense cost in effort, material, and time.[43]

This provides an opening to examine the extent to which the Navy estimated the impact that design changes would have on the program. Were the changes piled on willy-nilly without considering the overall consequences, or did the Navy attempt to assess the effect of changes on the program as a whole before deciding to go ahead?

The Navy did in fact consider the question before deciding to incorporate the lessons of the Passaics' combat experience in later classes. Stimers discussed the issue at the Navy Department, where, "it was well shown that it would cost a great deal of money to make the changes, and would make great delay." The issue went at least as far as Assistant Secretary Fox, who "said he supposed if we went on in this way and made changes, every time a monitor was in a fight it would cost a million of dollars; but notwithstanding that, he supposed it was the best plan to pursue." Later that year, Stimers told the contractors explicitly that all the vessels under construction "shall have incorporated in them all the improvements which our experience and a study of the subject shall point out."[44]

Fox supposed that making changes during construction was the best plan, but at this remove it is difficult to tell just what factors influenced him most. It does not seem to have been possible at the time to reliably estimate the delays implied by the different courses of action; it may not even have been understood that those delays would differ. It is clear that the Navy (however imperfectly) considered the potential expense and delay before deciding to modify the ships under construction. Fox's supposition was a defensible decision, explicitly taken.

It was also a very bad decision, at least in retrospect, and later successful acquisition programs generally took the "build it now, change it later" approach, or incorporated modifications gradually in series production. In World War II, for example, the B-29 bomber occupied a position analogous to that of the ironclad in the Civil War: technologically

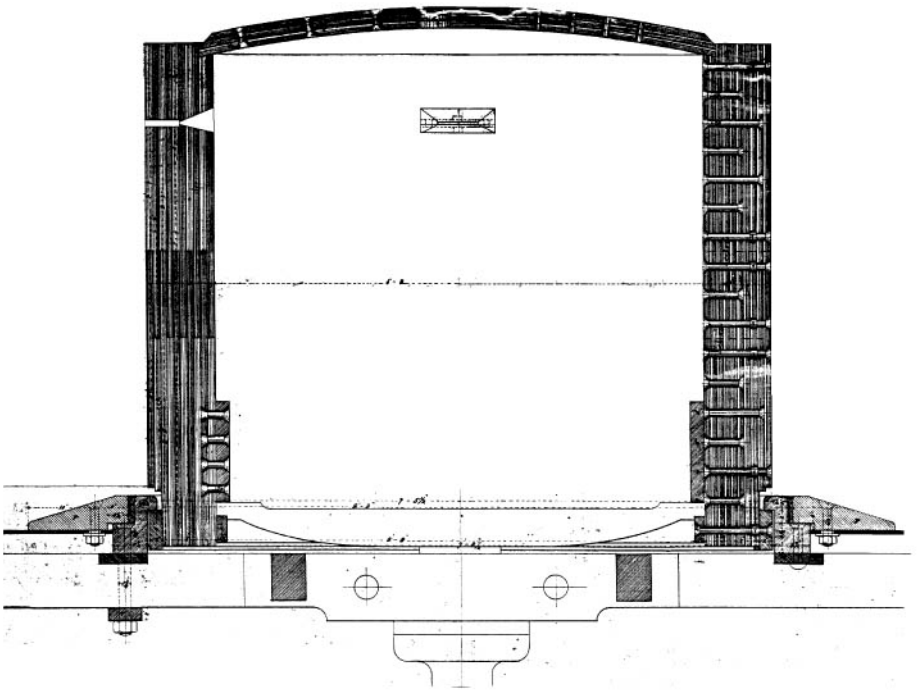


Fig. 6.6. The pilot house of the Tippecanoe-class monitor USS *Manayunk*. This drawing shows the pilot house as redesigned in 1863, with the complex riveting scheme clearly visible on the right. An angled bronze glacis ring has been added to protect the joint connecting the pilot house and the turret and to reduce jamming. National Archives and Records Administration, Record Group 19, BuShips Plan 1-11-9.

"very ambitious . . . for its day, pressing the state of the art in a number of areas." As with the monitors, intense wartime urgency caused orders to outrun testing: the government ordered 1,600 B-29s before the first one lifted off the ground. Just as monitor production was spread among several shipyards, B-29 production was parceled out to several contractors, with the same goal of greater and quicker production and similar resulting complications. In the World War II program, the Army Air Force froze the bomber's design, introducing changes very gradually so as not to upset production. Newly manufactured bombers flew first to modification sites, where each was brought up to the latest configuration.[45]

While bombers built on an assembly line may be considered mass

production, another example involved specialty items. The U.S. Navy's World War II submarines were built in identifiable classes, like the Civil War monitors, but differed in that the much larger number of ships involved meant that the submarines would be produced in sequential batches rather than simultaneously.[46] Thus the submarine program displayed both "build it now, change it later" and continuous improvement philosophies in proportions that varied over time. Early in World War II, simultaneous production of the first batches of American submarines gave that program a close resemblance to the Civil War monitor program. During this early-war period, contractors stoutly resisted any changes because they would unduly delay production. Until 1943, contract-built boats were completed to contract specifications, then taken to Navy yards for updating. Navy-yard built submarines, however, incorporated all the latest improvements.

As sequential production of submarines began to take hold, the Navy's construction bureaus came under increasing pressure from the fleet to incorporate lessons learned and provide up-to-date ships. Under these conditions, the Navy finally threatened to require contractors to build strictly to Navy yard plans. A compromise resulted: the contractors agreed to make continuous improvement changes that the Navy deemed mandatory and the Navy agreed to pay for them.[47] For the period during which the submarine program most resembled the monitor program, the contractors' "build it now, change it later" system was at least as successful as the Navy yards' continuous improvement method.[48]

Continuous improvement could succeed in Navy yards because they differed from private shipyards in two vital ways. Just as in the Navy yards of the 1850s, the Navy had full control over its personnel. If the chain of command wanted to modify a ship under construction, the shipyard would comply. More important, the Navy yards in effect had unlimited capital. They had to justify their expenditures to their superiors and to Congress, but they did not need to fear bankruptcy, as civilian contractors would if changes stretched out construction and delayed payments.[49]

In World War II, the Navy was able to design and build its own ships in Navy yards, using the continuous improvement philosophy, in competition with private shipyards that preferred the "build it now, change it later" approach. During the Civil War, the Navy could not build iron

ships in its own yards. It was, as Percival Drayton, the captain of the *Passaic*, wrote, "completely at the mercy of the contractors."[50] The Union Navy understood that it depended upon contractors to build its ships but did not understand that a shift in philosophy, from continuous improvement to "build it now, change it later," would be needed to minimize the effects of that dependency.

The Navy had before it in 1862 a prime example of the failure of continuous improvement construction when applied by a contractor. In 1842, Robert L. Stevens, a Hoboken, New Jersey, engineer, had proposed to build an ironclad warship, which he offered to complete in two years. Congress appropriated $250,000 for the project, and Stevens began work in February 1843. In November 1844, he negotiated a second contract, which called for completion in November 1846 at a total cost of $586,717.84. By 1862, Stevens's heirs wanted some $800,000 more to finish the ship, still far from completion. The project never was finished, one author observed, because it changed every time someone developed a more powerful gun. "Much has been said about [Stevens's] genius, his work, &c.," Senator William P. Fessenden observed. "Why, sir, in the process of the work on this vessel, the thing was changed over and over again. . . . The genius changes its operation and direction from month to month and year to year."[51] The Navy Department, which in 1862 had opposed spending more money on the Stevens Battery for precisely this reason, nonetheless embraced Stevens's philosophy of continuous improvement in the monitor program. With similar philosophy came similar effects: cost overruns and delivery delays.

CHAPTER 7

Progress Retarded

The Harbor and River Monitors, 1863–1864

"Continuous improvement" directly affected the harbor and river monitors. After Stimers's letter of December 22, 1862, construction more or less paused on all the vessels—Stimers's draftsmen could not furnish drawings of the accumulated changes rapidly enough to keep the work moving. Even the drawings they did produce were still based on educated guesses, since the computations from the deepening were not completed until April 1863.

The contractors quickly recognized the problems caused by the Navy's alterations. As early as January 12, 1863, some contractors questioned Stimers's authority to make the changes.[1] The Secors and Harrison Loring were the first to complain. Because their ships had made the most progress, they were the most affected by changes, reworking, and delays. In early April 1863, both complained to Fox that their work was being held up for lack of drawings; in another letter to Fox, Secor & Co. noted "many important changes" to the monitors and requested financial relief for the extra work.[2]

Stimers reacted by recommending that the Navy not enforce any forfeitures for failure to complete the vessels on time. Conceding that the changes made it "very difficult to decide exactly how much time should be added to that specified," he suggested the forfeiture clause be disregarded for the entire Tippecanoe class. There was precedent for such a waiver, because forfeitures had not been imposed for late delivery of any of the first-generation ironclads.[3]

In June, Secor & Co. complained directly to Welles, noting that the amount it had been advanced fell far short of the cost of the alterations and reporting "a very wide difference of opinion" with Stimers as to the

amount to be allowed for the changes. Besides asking for additional progress payments, the Secors asked Welles to establish a board to determine fair compensation for the unexpected costs caused by alterations and improvements.[4]

Welles reacted to the contractors' growing concerns by limiting Stimers's authority to impose changes and by appointing the board the Secors requested. In mid July 1863, Welles told Gregory that his subordinates (i.e., Stimers) were not to modify contracts or instructions to contractors without bureau approval. Also, Welles insisted, all correspondence to contractors would go through Gregory.

Other contractors complained to Gregory, who returned from a mid-August visit to Reaney, Son & Archbold with an earful about Stimers's methods. To ensure that the contractors knew of the policy change, Gregory wrote to each on August 21, 1863, telling them, "the General Inspector and his subordinates will not be permitted to alter plan[s], or modify contracts or instructions, unless authorized by the Department, or the proper Bureau—which in all cases must be through the General Superintendent." He required each to acknowledge his letter.[5] It appeared that Stimers's autonomy had been reduced and a check placed upon his independence.

Stimers's technical reputation had peaked in the wake of Du Pont's attack on Charleston, however, and his relationship with Fox markedly diminished the impact of such restrictions. In a letter to Fox, Stimers asserted that Gregory had told him verbally to disregard the Navy Department's direction, only to reimpose the rule when the department repeated its injunction. Gregory then had Stimers draft an order for Gregory's signature that delineated what letters Gregory would sign. The admiral began to suspect, however, that Stimers was still dealing directly with contractors, so he directed that all of Stimers's correspondence go through him. Stimers used the excuse that Gregory had placed some letters in the wrong envelopes to ask Fox to override this order, but Fox does not appear to have done so.[6]

Fox's reluctance to override Gregory may have stemmed from the escalating cost and schedule difficulties of the monitor programs. Fox told Gregory on October 9, 1863, that the claims arising from alterations made it necessary to appoint a board to assess the situation, determine how much was owed to the contractors, develop a plan to complete the ves-

sels, and report on how much it would cost.[7] Reading between the lines of this relatively bland letter, one can conclude that the program was in trouble and that the source of the trouble was incessant alterations. It was a portent. Fox esteemed Stimers primarily for his ability to get results, as he had done first with the *Monitor,* then with the Passaic class. Delays and cost overruns would necessarily diminish his influence.

The claims board, under Gregory's presidency and including Stimers, met sporadically beginning in October 1863. It reviewed the cost of the changes already ordered and in many cases gave the contractors additional compensation for them.[8] Fox intended the Gregory board to clear up the accumulated charges, after which a new system of negotiating changes would prevent further disputes. The idea that both parties would benefit from agreement on the price and scope of work was sound, but its implementation suffered from the small number of changes to which it applied, the increasingly adversarial relationship between the Navy and the shipbuilders, and the way it dealt with (or failed to deal with) prevailing economic conditions.

Although negotiation was to be used throughout the ironclad program, very few changes were actually processed in this fashion. In later testimony, Stimers described the system as one of "having the costs all settled before we did anything about it" but noted that "it really never got to a system." While the Navy tried to make negotiation work, "that system applied to so small an amount as compared with the whole amount, that it didn't amount to much." Theodore Allen, Stimer's assistant, testified: "This was never carried out as a system . . . we could only consider to what extent [the bills] were extra as regards the contract, without taking into consideration any delay or any probable rise in materials." The Inspectorate of Ironclads would compare estimates from several shipbuilders for identical alterations, establish a price, and pay each builder alike.[9]

Stimers's testimony here confirms that the Navy considered the "build it first, change it later" system. If the estimate for a particular change were too high, he said, the Navy would "say that we either wouldn't have it done or that we would do it ourselves, or wait until the vessel was done and then do the alteration ourselves." This policy applied primarily to the eastern-built ships of the Tippecanoe class. These vessels were so far ahead of the western-built monitors that some alterations could not be applied by the building yards without further delaying the ships.[10]

The contractors did not always acquiesce. M. C. Hill of the Niles Works reminded Stimers that a change that reduced the amount of work would not always save money, given the cost of "writing, estimating, giving orders & directions to workmen, and delays occasioned." Hill later wrote: "You say 'you can get other parties to make those [pinions] for the "Catawba" & "Oneota" if we do not want the job.' You can do just as you prefer." Nathaniel Thom, Greenwood's superintendent, advised Stimers that he had reduced his estimates as far as he could without losing money. The high prices of metal and labor made it "almost impossible to cover the cost of executing any piece of work by any reasonable figures."[11]

The growth, or regrowth, of adversarial relations between the Navy and its contractors contributed to the failure of the negotiation system. Antagonism grew, of course, as delays mounted: the Navy felt that the contractors had agreed to build desperately needed ships, which were not yet built. All nine ships of the Tippecanoe class were to have been completed by March 15, 1863, but the first vessel afloat, the *Canonicus*, was not launched until August 1, 1863, and the *Tecumseh* and *Manhattan* not until September 12 and October 14, 1863, respectively. If in hindsight one allows the contractors six months' extra for the delay caused by the December 1862 redesign, they were still launching the first ships of the class when they should have been completing the last of them.

The western monitors had fallen even farther behind schedule than the eastern ships. In early October, Chief Engineer King's report showed that none of the Cincinnati ships was ready for launching; no armor had yet been installed on the *Catawba*, the farthest along, and neither the *Oneota* nor the *Tippecanoe* had all their hull plating yet. Inspector Charles Loring noted a number of causes, including the low state of the Ohio River, which prevented coal from getting to the iron mills. "The progress of this vessel is considerably retarded," Loring wrote of the *Tippecanoe*, and this was true of all the ironclads being built by western contractors. From Pittsburgh, King advised in February 1864 that Snowdon & Mason could not deliver the *Manayunk* and the light-draft *Umpqua* in less than a year.[12]

The Navy's reaction to the delays was exacerbated by the feeling that the contractors were profiteering at the nation's expense. Stimers clearly displayed this attitude when he told Fox that the contractor for the iron-

clad *Keokuk*, Charles W. Whitney, was deliberately slow, because with fewer men he could work more efficiently and reduce his costs. Moreover, "by keeping up the delay long enough the forfeiture will be so great that to demand it would appear to be very unjust." Contractors, Stimers asserted, "really have no patriotism, self love always being greater than love of country, especially among people who remain at home and grow rich in time of war."[13]

The state of the Union's finances complicated the issue. Stimers later wrote that the Navy had little time to listen to arguments that would take money out of the Treasury. "We were paying it out so fast that it was incumbent upon every officer to get all he could for the Government and pay as little as possible for it."[14] Combining an adversarial relationship with a perceived need to get the most from every government dollar encouraged the resurgence of the 1850s style of management in which the government used money as a club with which to beat contractors.

From the shipbuilders' point of view, things looked different but no less adversarial. The Navy had failed to provide the construction drawings as promised and had made many alterations, each of which increased the ships' cost and delayed their completion. Excepting the vague language of Stimers's letter of December 22, 1862, however, the government had neither extended the time allowed nor compensated the contractors for their extra work. Even when the Navy approved the contractors' bills, the Treasury would not pay them promptly. In effect, the shipbuilders had to finance the vessels themselves. At one time, Charles A. Secor recalled, the government owed the Secors' firms nearly $800,000, and Secor told Fox that he would have to stop work unless the Navy paid something on account. Fox told Secor "that 'those were war times' and they, if we stopped worked [*sic*], would have to take possession of our yard and establishment." If the Secors stopped work, Fox said, he "would send a file of Marines to take the charge of our works." With the survival of their business at stake, the Secors felt "wronged and cheated" by the Navy.[15]

The contractors' distress stemmed from several causes, but chief among them were the markedly increased prices of materials and labor—during the period from 1860 to 1865, consumer prices in general almost doubled, (see Table 3), primarily as a result of government policy and shortages of materials and labor.

In the policy area, although the Union paid for more of its war effort out of tax revenue than did the Confederacy, inflation inevitably accompanied the transition from specie to paper money. As government borrowing rose, the specie value of the dollar fell proportionately, and contractors besieged Welles for compensation. Contractors were also hurt by the taxation program of July 1, 1862, which included not only an income tax but an excise tax of 3 percent on all manufactures. This included items manufactured for the government, and contractors quickly began to lobby the Navy Department for exemptions (which apparently were not granted).[16]

The Navy held a hard line on this issue because it directly reflected on the credibility of the Union government. The Lincoln administration asserted that inflation and depreciation were not its fault, and Stimers later wrote: "The instructions from the Navy Department were to pay for the changes themselves, but to allow nothing for the increased cost of the original contract work because, as it was verbally explained to me in the Navy Department, this increased cost was due to the state of the country

Table 3

The Composite U.S. Consumer Price Index, 1860–1866

Year	*Composite Consumer Price Index*	*Increase over previous year (%)*
1860	100	—
1861	106	6.0
1862	121	14.1
1863	151	24.7
1864	189	25.1
1865	196	3.7
1866	191	-2.5

SOURCE: John J. McCusker, *How Much Is That in Real Money? A Historical Price Index for Use as a Deflator of Money Values in the Economy of the United States* (Worcester, Mass.: American Antiquarian Society, 1992), 328.

at the time, for which the Government was not responsible."[17] The government contended then, as it did later in court, that businessmen of "ordinary prudence and diligence" should have been able to purchase most of their materials before prices began to rise. In retrospect, it is difficult to see how men accustomed to relatively stable prices could have foreseen the magnitude of the inflationary pressures upon them, or how even the most diligent businessmen could have purchased materials without knowing what they needed to buy.

Thom kept a record of the prices paid by Greenwood, which shows the rise in prices for specific shipbuilding materials (Table 4) as opposed to the consumer price index (Table 3). By mid 1863, common plate, bar, and angle iron had risen 35 percent, brass castings had risen 14 percent, iron forgings had risen 71 percent, and iron castings 50 percent from their prices when the *Tippecanoe* contract was awarded. By 1863's end, structural iron was up 75 percent, brass castings 43 percent, forgings 114 percent, and iron castings 108 percent from their initial prices. The shipbuilder George Quintard prepared a similar table reflecting New York prices. This "Quintard Table," forwarded to Lenthall by Gregory in July 1865, shows structural (refined bar) iron rising 52 percent between September 1862 and December 1863, and copper and tin, the raw materials for brass, rising 51 and 32 percent respectively.[18]

While the percentage increases Quintard recorded are generally comparable to those experienced in Cincinnati, the actual money values were not. In December 1863, bar iron cost 8.75 cents per pound, or $175 per ton, in Cincinnati, and $110 per ton in New York. This corroborates Cincinnati shipbuilders' claim that prices were higher in the West. When asked whether he had compared the Quintard table with his own, Thom testified that he had done so frequently, and that Cincinnati prices for both labor and material were considerably higher than in New York.[19]

Stimers's decision to establish a flat rate for alterations magnified the western builders' disadvantages. During the winter of 1863, he fixed the price for plate and angle iron erected in a vessel at 20 cents a pound, inclusive of labor. For bar iron and plain forgings, also erected inclusive of labor, the price would be 12 1/2 cents a pound. Of this, 60 percent was considered to be for labor and 40 percent for material.[20]

At that rate, a ton of bar iron worked into a ship in March 1863 would earn $250 for the contractor, of which $100 would nominally pay for the

Table 4

Extracts from N. G. Thom's Record of Prices Paid by Miles Greenwood

Month	*Plate, Bar, Angle Iron*	*Brass Castings*	*Forgings*	*Iron Castings*
Sept. 1862	5	35	7	3
Oct. 1862	5	35	7	3
Nov. 1862	5	35	7	3
Dec. 1862	5.5	37	8	3
Jan. 1863	6	37	7	4.5
Mar. 1863	6.75	37	8	4.5
Jun. 1863	6.75	40	12	4.5
Sept. 1863	7.75	45	15	6.25
Dec. 1863	8.75	50	15	6.25
Jan. 1864	8.75	55	16	7
Mar. 1864	9.25	55	16	7.5
June 1864	9.75	60	14	9
Sept. 1864	10.75	65	14	10
Dec. 1864	10.5	70	15	10
Jan. 1865	10.5	70	15	9.5
Mar. 1865	10.5	67	15	9.5
June 1865		60	12	9.5
Sept. 1865		65	12	9.5
Dec. 1865		65	12	9.5

SOURCE: National Archives and Records Administration, Record Group 123, entry 1, Case 6326, Swift v. United States.

Prices are in cents per pound.

iron. For a New York firm, buying bar iron at $100 per ton, there was room for profit. In Cincinnati, where at that time Greenwood had to pay $135 per ton for iron, as well as higher prices for labor, there was no margin. In this respect as in others, the Navy did not adjust its contracting policies to account for regional differences in contractors' costs. The

ironclad program was an open system, subject to influences from its environment; the Navy was trying to manage it as if it were a closed system, responding only to stimuli from within.

Important as were material price increases, they were overshadowed by the contractors' inability to deal with steadily increasing labor costs and shortages. The initial problem was a nationwide shortage of skilled labor. Harlan & Hollingsworth noted in August 1862 that the demand for workmen who could build iron hulls was "*so far* beyond what has been the requirements in the merchant service heretofore, that the supply cannot in reality be obtained." Beyond even that, as Stimers wrote in October 1862, the country had no experience in "building structures composed of such heavy, unyielding plates of iron. . . . Such work had never been done on an extensive scale in this country."[21] Thus the nation as a whole was short of the proper trades, and of the few with ironworking experience, even fewer lived west of the Alleghenies.[22] The shortage of skilled workers plagued the western builders from start to finish.

This western shortage of skilled labor led directly to constantly increasing wages. Besides his record of prices, Thom kept track of an average wage for those who worked in the shiphouse, that is, directly on the ship. Comparing his figures with those of the Quintard Table, Greenwood paid an average wage for all trades, skilled and unskilled, that was very close to the East Coast wage for boilermakers, among the most highly skilled and highly paid metal tradesmen. (Since Swift competed in the same Cincinnati labor market, his rates of pay had to correspond to Greenwood's.) These attractive wages help lend credence to Charles Loring's impression that many of Swift's mechanics came from the East especially to work on the monitors. While Loring did not know the relationship between Cincinnati and East Coast wages, "it is evident that, while there was constant demand for skilled labor there, mechanics would not leave home and old associations except for a higher rate of pay."[23]

The Swift/Niles consortium aggravated its own labor difficulties and Greenwood's, too, when it took contracts in late March 1863 for two light-draft monitors. Swift planned to build the hulls of the *Klamath* and *Yuma* in the shipyard of Samuel and Thomas Hambleton, just upriver from Litherbury's establishment, and to subcontract much of the machinery to the shops of Moore & Richardson. By mid 1863, three shipyards were

building five ironclads in Cincinnati, and the labor problem was acute. Despite the high pay, shipbuilders found it almost impossible to obtain skilled workers.

At Stimers's direction, local inspectors reported the average number of men who worked on each ship. It is difficult to draw precise conclusions from these data. Reports were rarely submitted if the regularly assigned inspector were absent, so the data must be compensated for "zero" periods during which work actually continued. In addition, it appears that no two shipyards and no two inspectors calculated or reported these figures in precisely the same way.[24] Some broad patterns may, however, be discerned.

The labor required to build a Tippecanoe-class monitor (exclusive of machinery and boilers) averaged some 12,700 man-weeks, but because of variations in reporting criteria, more detailed comparisons among contractors are misleading.[25] Contractors who built multiple ships presumably used the same reporting structure throughout, so comparisons among a single contractor's ships have more validity. Even so, the results are mixed. In Cincinnati, Swift & Co. expended some 14,500 man-weeks on the *Catawba,* the lead ship of the Swift/Niles pair, and 11,700 on the *Oneota,* a decrease of 19.3 percent.[26] Of the Secors' three ships, the *Tecumseh,* the first, required almost 11,000 man-weeks. The *Manhattan,* the second, required just over 11,300 while the third, the *Mahopac,* absorbed 12,700, a 15.4 percent increase over the lead ship.[27]

A chart of the number of workers employed on the Tippecanoe class shows the labor advantage of the experienced shipyards (Fig. 7.1). Comparing the shapes of the curves, the eastern shipbuilders got off to a quicker start on their five ships than the western shipbuilders did on their four. The downturn visible in both eastern and western curves in early 1863 is probably the result of the design revision of December 1862, while the sharp drop in eastern employment in late June and July 1863 results from the combined effects of the Confederate Gettysburg campaign and draft riots in eastern cities.

The magnitude of the labor shortage, at least in the West, may be inferred by comparing employment with the 1860 census. By the end of March 1863, there were 335 men employed building harbor and river and light-draft monitors in Cincinnati, not counting those engaged in building the ships' machinery.[28] In mid May, the number had climbed to 419,

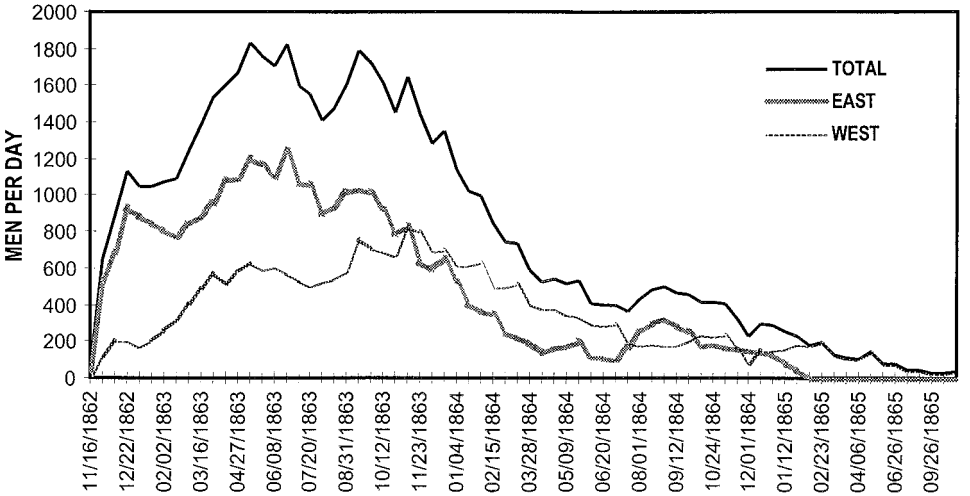


Fig. 7.1. Number of workers employed on Tippecanoe-class monitors (smoothed). "West" includes the *Catawba, Oneota, Tippecanoe,* and *Manayunk;* "East" includes the *Saugus, Canonicus, Mahopac, Manhattan,* and *Tecumseh.* Various sources.

and by late June it was over 500. From September 1863 through early May 1864, the number never fell below 700, peaking at 1,063 in November 1863 (Fig. 7.2). For the reasons mentioned, these figures probably understate the actual employment by 50 to 100 percent. At its peak, the monitor program's shipyard workforce equaled about one-third of the entire prewar Cincinnati population of ironworkers, shipbuilders, and machinists.

Pittsburgh's situation was similar, but the labor market there was smaller and tighter. In 1860, 143 men had been engaged in shipbuilding at Pittsburgh and Brownsville, yet Snowdon & Mason's employment on the *Manayunk* alone (exclusive of machinery) peaked at 243 hands. In addition to the *Manayunk,* by mid 1863, Snowdon & Mason were building the light-draft *Umpqua,* and Tomlinson & Hartupee were building the gunboats *Sandusky* and *Marietta.*

Labor mobility was significant in Pittsburgh as well. Alexander Jack, a boilermaker, had worked for Tomlinson & Hartupee for $2 a day. He started at Snowdon & Mason for $2.25 a day in winter 1862 and stayed until late summer 1863, when "I quit because I wanted $3.00 per day." He

went to work building a railroad bridge at $16 a week ($2.67 a day), soon raised to $18 a week. Lewis T. Brown had been an ironworker before enlisting in the Army the day after Fort Sumter; after recuperating from a wound received at Gettysburg, he never returned to his regiment. He worked for Snowdon & Mason as a driller, then took over the planer in the machine shop. Drilling, he made $1.50 per day; at the planer he made $3.00 per day. He left Snowdon & Mason for another planing job at $5.00 per day. Snowdon & Mason found themselves so desperate for labor that John Snowdon, a native Englishman, returned to England and recruited ironworkers there to bolster his workforce.[29]

Labor strikes seem to have been a significant problem in eastern shipyards. Some New York shipbuilding trades struck in late 1862, while in the spring of 1863, New York suffered a wave of organizing and strikes. Strikers stopped work at the Boston Navy Yard three times during 1863, and a long and bitter machinists' strike affected New York in the autumn and winter of 1863-64.[30] In the West, however, the very tight labor market made strikes infrequent and short-lived. Thom, in fact, asserted there were no strikes in Greenwood's works because, "We were obliged to give them just what they asked, and there was nearly every two weeks for a long while, a rise in the price of labor." Ten years had blurred his recol-

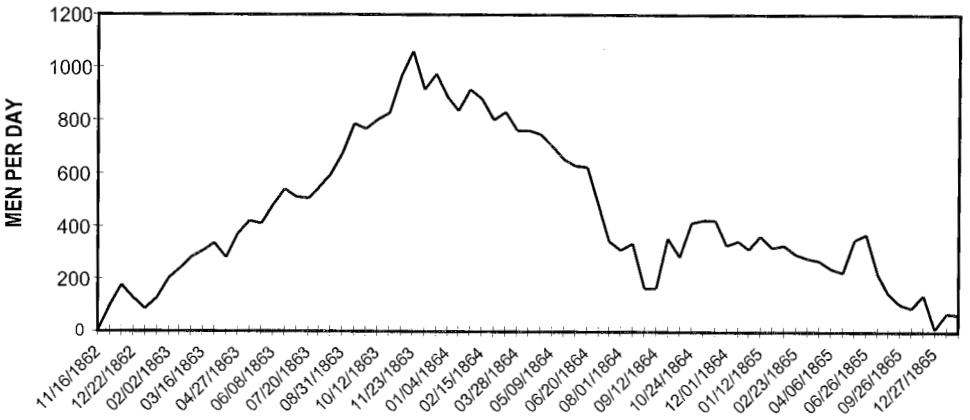


Fig. 7.2. Number of workers employed on monitors in Cincinnati (smoothed). Includes the harbor and river monitors *Catawba, Oneota,* and *Tippecanoe* and the light-draft monitors *Klamath,* and *Yuma.* Various sources.

lection, but he was close to correct; only five strikes appear in the inspectors' reports, and there was a generally steady upward trend in wages (see Table 5). Compared to New York, Cincinnati was a model of labor peace, albeit a peace for which employers paid top dollar.[31]

Conscription compounded the initial shortage of skilled iron workers. Some skilled men were lost directly because they were drafted and held to service in the Army or enlisted under threat of being drafted to earn a volunteer's bounty and respect. Others moved from community to community to settle where draft calls would be low. Still others moved from private industry, where they were subject to the draft, to government employment, where they were much less so.

Shipbuilders saw from the first that conscription would make already scarce skilled labor even scarcer. If they could protect their workmen from conscription, however, they could turn draft exemption into a powerful tool to attract and keep skilled workers and to reduce demands for wage increases. Shipbuilders began to lobby for blanket exemption as early as August 1862, when Harlan & Hollingsworth described the situation to Welles. After discussing the underlying shortage of skilled workers and the draft as an incentive to volunteer, they wrote, "We see the ranks of our workmen thinned day after day without any hope of recruiting or obtaining men that can fill their places. . . . the difficulty may be speedily remedied by exemption."[32]

Harlan & Hollingsworth had heard that New York firms had applied for exemption, and Ericsson, with eight vessels building or subcontracted by his group, echoed Harlan & Hollingsworth's support for the measure. "I trust you will be able to procure exemption from drafting for all hands employed on the Iron Clad Navy," he wrote Fox. "If you cannot, the Country must then look to its soldiers alone for protection for a long time to come." Yet not every shipbuilder favored exemption. Barnabas Bartol, of the Philadelphia firm of Merrick & Sons, advised against it, writing that exempting only a few firms would cause general discontent.[33]

Western firms began to lobby for exemption even before they received monitor contracts. In mid August, Swift asked Welles to exempt his iron mill workers from conscription because they were making iron for gunboats, saying that it was difficult to carry on the work because many men had left. Swift & Co. wanted to be able to tell its men that "they need not

Table 5

Wages from N. G. Thom's Record of Prices Paid by Miles Greenwood

Month	*Average Wage per day (Thom)*	*Laborers (Quintard)*	*Boilermakers (Quintard)*
Sept. 1862	1.42	1.10	1.80
Oct. 1862	1.67	1.10	1.80
Nov. 1862	1.66	1.10	1.80
Dec. 1862	1.67	1.10	1.80
Jan. 1863	1.79	1.10	1.90
Mar. 1863	2.09	1.20	2.00
June 1863	2.27	1.40	2.30
Sept. 1863	2.47	1.40	2.40
Dec. 1863	2.73	1.50	2.75
Jan. 1864	2.54	1.60	2.80
Mar. 1864	2.88	1.90	2.90
June 1864	3.28	2.10	3.10
Sept. 1864	3.34	2.20	3.20
Dec. 1864	3.30	2.20	3.20
Jan.1865	3.47		
Mar. 1865	3.51		
June 1865	3.30		
Sept. 1865	3.48		
Dec. 1865	3.18		

SOURCE: National Archives and Records Administration, Record Group 123, entry 1, Case 6326, Swift v. United States; "Quintard Table" wages extracted from *Certain War Vessels Built in 1862–1865*, Senate Report 1942, 57th Cong., 1st sess., June 17, 1902, 9–10.

Wages are in dollars per day.

enlist for fear of a draft." Welles replied that while workmen in private establishments could not be exempted, "if skillful workmen employed upon work for this Department, and whose absence would seriously hinder its completion are drafted," the Navy Department would try to get them discharged. Exemption was thus to be individual and after the fact rather than on a blanket basis. Welles answered other inquiries in the same language.[34]

Among the first to request release of individuals from service was Greenwood, although his case required no interdepartmental cooperation. In October 1862, he asked for two men who had enlisted in the Navy's Mississippi Flotilla, and Welles told the commandant to grant the request if the men could be spared. In the same month, Reaney, Son & Archbold asked for the release of twenty men from the Army draft, which the Navy obtained from the War Department. Niles Works asked Fox for help in December, and he obtained the War Department's order to discharge twelve men.[35] It appeared that the government could balance the Army's need for men with the Navy's need for skilled workers to build and repair its ships.

As the war continued, however, the climate changed. Secretary of War Stanton began to enforce the conscription law to the letter, even drafting men for the Army who were already on active duty with the Navy. By March 1863, Welles would no longer approach the War Department to discharge an artisan who had volunteered, and by July, he had to advise naval contractors that Stanton "declines to grant exemptions from draft, or to suspend its operations, in any case."[36] Changes in the draft law in the summer of 1864 remedied some of the major injustices, but while civilian workmen in government employ could avoid the draft, workmen in civilian establishments remained subject to it.[37] The Union never satisfactorily solved the problem of allocating its manpower between direct military needs and war production.

Besides the common difficulties of inflation, soaring costs, and scarce manpower, Cincinnati shipbuilders faced problems that coastal shipyards found less pressing. Cincinnati occupied an exposed position, separated from ambiguously loyal Kentucky only by the Ohio River, and martial law affected Cincinnati shipbuilders in several instances. In August 1862, Confederate General Edmund Kirby Smith moved into central Kentucky, causing great concern that Cincinnati was his objective. Un-

ion Major General Lewis Wallace assumed command of the city, closed all businesses, and impressed all able-bodied men to work on the city's defenses.[38] The "Kirby Smith raid" did not directly affect the monitors, which had not yet been begun, but it made Union authorities sensitive about the Queen City. Martial law was again declared in the summer of 1863, delaying work for several days. In May 1864, the state of Ohio called out the militia in response to Colonel John Hunt Morgan's advance into West Virginia and Kentucky, and it took two weeks to get men employed on the monitors excused from militia duty.[39]

The weather also affected western shipbuilders more than easterners. A more severe climate caused inland shipbuilders to lose more working days in winter than their seacoast counterparts, but this inconvenience was relatively minor compared to the disadvantages of a freshwater site. The same cold weather that impeded progress in the shiphouses froze the Ohio River and prevented iron from moving from the mills on the Kentucky side to the shipyards on the Cincinnati side.[40] Once the ships had been launched, winter weather sent chunks of ice drifting down upon them. The most serious problem, however, was the dramatic and unpredictable seasonal variation in river levels.

Even before the *Tippecanoe* contract was awarded, the Navy had required Greenwood to prove that he could actually deliver his monitor at Cairo. When the river level was high, this would not be difficult. At low water, however, the Tippecanoe class could not pass the 24-inch-deep falls at Louisville nor get over Scuffletown Bar below Louisville, where one could expect only 22 inches at low water.[41]

Despite Rear Admiral David Dixon Porter's assertion that depth made no difference, because "at low water, the whole Mississippi is a chain of sand bars," the rhythm of construction depended heavily upon the river level.[42] Very low water in late 1863 caused a coal shortage that reduced or stopped the iron mills' output. Similarly, low water affected not only the transit to Cairo for delivery but the launching and fitting out of the ships. When the river was low, the water's edge receded down the bank and was farther from the ship. The builders could extend the launching ways, but that would cause the ship to be moving more rapidly than normal when she reached the water. Since the river itself was narrower and shallower than usual, a low-water launching in Cincinnati would have yielded a damaged monitor stuck stern-first in the mud on the Kentucky

shore. By April 1864, the *Catawba,* the most advanced of the Cincinnati ships, was ready to launch at the first rise of the river.[43]

April 13, 1864, saw that rise. At 12:30 P.M., shipyard workers knocked out the last restraints and the *Catawba* started down the ways, with some 150 men and women on deck and a crowd of thousands watching from both sides of the river. The ship's sponsor, Emma Bickerstaff, christened her with a bottle of sparkling Catawba wine; the thoroughly drenched color party at the stern raised the national ensign; and the wave the ship made knocked down many of the spectators crowded at the foot of Butler Street. Stimers, too eager to wait for Loring's official letter, advised Gregory of the launch based on reports from the Cincinnati newspapers. This first launch of a monitor west of the Alleghenies was clearly cause for the general inspector to celebrate.[44]

Although high water permitted the *Catawba* to be launched, it immediately placed the vessel at risk. The swift current swept her toward the steamboats at the landing, and only quick action snubbed her enough for tugboats to get her under control. The tugs returned her to the foot of Swift's ways for fitting out, and while the invited guests went across the street to the Niles Works office for a reception, the shipyard went back to work.

Loring estimated five months to complete the *Catawba* if she remained at Cincinnati, but again, the stage of the river affected her progress. If the remaining work were to be done at Cincinnati, the ship would be completed in the autumn, when the river would probably be too low to permit her passage. If Swift took advantage of the existing high water to tow her downriver to Cairo, the lack of facilities and workmen there would delay her completion and make it much more expensive. "There has not been sufficient water in the river to pass these vessels over the falls at Louisville since March 1863,"[45] Loring noted.

Low water thus posed a financial as well as a technical problem. The government had held back (reserved) part of the contract price as a performance bond, and the Navy would not pay this reservation until it accepted the ships. The contracts, though, called for delivery at Cairo. If low water prevented the ships from passing downriver upon completion, not only would the contractors have to wait for their money, but they would have to pay the expenses and bear the responsibility of keeping the ships safe until they could be delivered. By the original timetable, de-

livery in Cairo looked like a good bet—the ships were to be completed in March 1863, when the river would likely be high enough for them. If they were finished in the autumn, however, they would sit at Cincinnati until the spring rise in the river released them. Accordingly, Swift proposed that the ships either be delivered at Cincinnati or the Navy should pay extra for delivery at Cairo. Welles promptly vetoed the proposal. The Navy expected the ships to be delivered in Cairo and would neither pay extra for that nor accept them in Cincinnati.[46]

The next monitor in line in Cincinnati was the *Oneota*. Swift took advantage of a rise to launch her on May 21, 1864, and the ship touched the "turbid water of the swollen river" at 3:00 P.M. that Saturday, with "hundreds" of people on board and thousands lining the riverbank. There were no untoward incidents this time, and by the end of the day, the *Oneota* was tied up next to the *Catawba* for fitting out. The launch, however, had been scheduled for May 24, and it had to be moved up unexpectedly when the river level began to fall.[47] Because Welles rebuffed his attempt to change the delivery point, Swift decided to complete the two ships in Cincinnati rather than take the incomplete vessels down the river.

Swift's need to make this decision points up a major difference between shipbuilding on rivers and shipbuilding on the Atlantic seaboard. Delivery, whether on a river or on the seaboard, depended in part upon water level. Seaboard-built ships depended upon tides, which were highly predictable and recurred daily. If an eastern contractor missed delivering a ship to a nearby Navy yard on today's high tide, he would have another chance tomorrow. Western builders depended upon river level, which was much less predictable and recurred on a roughly annual basis. If the western contractor missed a rise in the river, it might be months before he would have another chance to deliver his ship to a Navy yard hundreds of miles away.

To take advantage of a rise, however, a contractor might have to move a vessel before completion. If so, uninstalled items would have to be sent by barge or rail, and the ship would have to be finished far from the contractor's shipyard, in a place where lack of facilities and skilled labor would make the work markedly slower and more expensive.[48] The uninstalled weight would lessen the draft of the ship somewhat, and every inch might help, but the possible gain had to be balanced against the certain increase in expenses and the equally certain delay in completion.

When the Swift/Niles consortium chose to complete their ships in Cincinnati, they probably did so because this was the least financially injurious course. By 1864, it must have been apparent to all of the contractors that the Navy would not enforce the contract's forfeiture clause, and absent any forfeiture, finishing the ships at Cincinnati would minimize expenses. This remained so even when the steadily dropping summer river levels reduced the shipbuilders' efficiency by compelling them to move the two ships upriver to deeper water a mile from their shops.[49] By the end of May 1864, the combined total of men employed on the *Catawba* and *Oneota* had fallen to under two hundred. Swift shifted much of the workforce to the light-drafts *Klamath* and *Yuma*.

The other western monitors fared less well. Both Greenwood and Snowdon & Mason approached Stimers for permission to launch their monitors on the spring rise before the decks were put on, but Stimers denied them both. "You ask me as I love my country and respect private interests" to allow the ship to be launched without the deck, he told Snowdon & Mason. "The Government is indeed in a great hurry for the vessel but it is a good strong vessel not an injured one that they are in a hurry for." Loring reported in May that the *Tippecanoe* would be ready to launch if the usual June rise took place, but this did not work out. Lacking sufficient skilled labor, Greenwood was making little progress, but since he knew that he could not launch the ship until the river rose, he may have been pacing the work to reduce his expenditures. The *Tippecanoe* was not launched until December 1864. Snowdon & Mason was reportedly ready to launch the *Manayunk* in April but did not do so because of low water. In July, Chief Engineer King advised Fox that the *Manayunk* and Snowdon & Mason's light-draft *Umpqua* were "in such incompetent hands" that he could not estimate when they might be completed.[50]

In March 1864, a year after the contracted completion dates, the harbor and river monitor program was in trouble. Of the nine ships ordered, only four had been launched, all in the East, and only three of those were near completion. The overarching cause was the inability of the monitor contractors to deal with rapidly changing conditions: design changes, inflation, labor shortages, and fluctuating river levels. Poor management comes immediately to mind, but inspectors made no complaints of incompetence against the Cincinnati or East Coast firms as they did

against Snowdon & Mason. The aggravating element common to all the shipbuilders was more or less inadequate capitalization. The difference between "more" and "less" was a key factor in determining each firm's success or failure. Simply put, poorly capitalized firms had no reserves when they were hit with the triple blows of rising costs, incessant changes, and slow government payments.

It is at first surprising that shipbuilders had such difficulty adjusting to changes, both in the ships they built and in the environment in which they worked. After all, shipbuilders, machine shops, and iron makers were specialty producers, whose livelihoods and businesses depended upon their ability to react to changing conditions through flexible management of highly skilled labor. While some firms were new to specialty production, others had been successful before and during the war; they had weathered economic hard times and recovered. Why, then, did sound businessmen have trouble building ironclads?

Stimers characterized the initial situation when he wrote that the contractors took the work "as a matter of business." If the price were fair, "they will make money if they conduct their work upon correct business principles, if they do not do this they will inevitably lose money unless we have given them a price which is larger than it should have been."[51] He was correct: none of the contractors set out to build monitors as a public service. Each expected to make a fair profit from his work.

A fair percentage of profit was variously stated. The most sophisticated analysis, by Cornelius H. Delamater, took the actual cost of payroll and purchased materials as the basis. Delamater then added 25 percent of that basis to account for rent, power, administrative costs, wear and tear, and tools, noting that the result was the actual cost of doing the work. He considered that 10 percent of the actual cost was a "fair and reasonable" profit. The Secors used the same method, adding 20 percent of the cost of labor and materials to get the actual cost and calculating 20 percent of that as profit. Less sophisticated men simply used a percentage, ranging from 10 to 35 percent, of the direct costs of payroll, purchased materials, and subcontracts. (Questioned about the 35 percent figure, one deponent asserted, "Why, men would make nearly that much money swapping jack knives at that time.")[52]

The shipbuilders had obviously thought to make that sort of profit. James F. Secor said the Secors had based their bids on the Passaic class.

"The Government had already given $400,000 for the *Passaic* class of vessels, and the modifications were estimated by Captain Ericsson, the designer of these vessels, to cost $60,000, and they added $60,000 to it, which made $460,000." His brother Charles testified that Ericsson estimated that the modifications "would cost about $40,000. Says he, 'Secor, you can make $20,000 on that, with your energies on these alterations.' " The Secors also hoped to earn the premium for early completion and had structured their subcontracts to that end.[53]

The western firms also thought that the undertaking would be profitable, since Swift and Niles immediately accepted a second vessel when it was offered at $460,000. They knew that the cost of building two identical vessels in series in the same shipyard would be less than building them separately, since they would save much of the startup cost for the second ship and could get more than one use from expensive items such as foundry patterns. In the normal course of events, they would have been right. Stimers, however, apparently saw $460,000 as a bargain for the Navy. Given that the contractors had bid $460,000 for much less ship than the government eventually demanded, he was right. As James Secor said, "if the specification that was shown bidders at Washington, when the bids were made, had been adhered to, there was profit in the contracts."[54]

The potential profit was large, but the contracts were also large, and executing them would tie up considerable capital for the firms that took them. Merrick & Sons, whose *New Ironsides* contract had been worth $780,000, had a capital of at least $200,000 in 1858, which grew by early 1864 to $700,000. Swift & Co., with contracts worth $920,000, was estimated in 1863 to be worth $100,000, and by March 1864, $150,000. Swift's partner, Niles Works, was worth $258,600 in late 1860. Greenwood's worth was not explicitly recorded before the early 1870s, but when the war began, R. G. Dun & Co. considered him wealthy. In the Snowdon & Mason partnership, Dun estimated the worth of Snowdon & Son at up to $100,000 in 1864. Dun credited Mason with "ample" means in 1861, but his worth in 1856 was only $8,000 to $10,000, including real estate, so his 1861 capital could not have been large.[55] The best-capitalized Western firm was the Swift/Niles consortium, and it was thus best able to withstand the drains on its resources and continue to forge ahead with its ships.

Matters stood similarly in the East. In 1864, Dun credited Harlan &

Hollingsworth with $500,000 in assets, and Harrison Loring was said to be worth $400,000.[56] Of the eastern builders of the Tippecanoe class, the Secors were the shortest of capital. In part, this resulted from their approach to building the ships, which had emphasized speedy construction for maximum profits. To gain speed, they had dispersed work to subcontractors and included premiums for quick delivery; to reduce expenses, they had leased the ground for their "expansion" yard for only six months. When construction dragged on, their subcontractors demanded significantly more pay and their rent rose sixfold.[57] Constant changes made their business strategy counterproductive—the faster they built their ships, the more they had to tear out and rework when the alterations arrived.

Contemporaries noted the Secors' relatively shaky capitalization. In February 1864, their ships were progressing "very slowly indeed." The cause, Stimers wrote, was that the contractors had insufficient funds unless the Navy paid them frequently. "Materials can be bought on credit, but labor must be paid for weekly, and I have observed that it is in labor only they are deficient." Stimers suggested a radical change in the Navy's policy toward contract work. Under his plan, the government would pay the weekly labor bills directly and charge the contractors' accounts, implying a later settlement. The Secors, he observed, "have remarkable energy and skill in advancing work when their finances are all right, but the work is now proceeding slowly in consequence, I think, of their want of money to pay for labor."[58] He could have said the same, in lesser degree, for any of the monitor contractors.

Stimers's unconventional proposal implies that he had begun to sense that the ironclad program's most pressing problems were no longer technical. It followed a progression similar to that ascribed to the electric power industry, in which an "inventor-entrepreneur" initially runs the show. Later, as the most difficult problems become managerial and financial, the system needs a "manager-entrepreneur."[59] Ericsson had been the monitor program's inventor-entrepreneur, the driving force upon whom all depended. Early on, Stimers had shown himself to be a capable manager-entrepreneur; building the inspectorate and breaking production logjams were giant steps toward the system's goal of providing usable ironclads promptly and in quantity. Yet Stimers derailed the system's initially smooth transition from inventor-entrepreneur to man-

ager-entrepreneur when he allowed himself to be seduced by ironclad technology. In the hothouse environment of the war, the system matured so rapidly that by 1863, Stimers's efforts to gain professional recognition by emulating Ericsson were counterproductive. Chasing the chimera of technical elegance, the general inspector gave short shrift to nontechnical problems, which daily became more serious.

Although the Navy did not adopt Stimers's recommendation to improve the contractors' financial picture, the shipbuilders themselves used every dodge they knew. One was a time-honored method of self-financing: slow payment to their suppliers. Some shipbuilders were slower than others. Zeno Secor was behind in his payments and received credit "more on the strength of his lar[ge] Government contracts . . . than from any knowledge of his own responsibility." Snowdon & Mason rated credit "with caution." The credit of Swift and Niles was never questioned; Greenwood's cannot be determined from available information.[60] Eventually, however, the contractors had to pay their bills, and they could not do it with the cash trickling in from the government.

One reason was the reservation system. In normal times, progress payments would relieve the contractor of most of the direct financial burden of building the ship, and the 25 percent reservation would roughly represent his overhead and profit, held as surety for the ship's performance. The Navy believed that surety was vital; in mid 1863, Welles had denied a contractor's request for payment of a reservation, saying it was not prudent to give up the only real security the government had.[61] The general inability of contractors to deliver as promised reinforced the attitudes engendered by the 1850s acquisition process.

In the inflationary environment of the Civil War, however, it was counterproductive to withhold funds from contractors who were already in financial straits, and by 1864 the Navy began to appreciate this. The government did not go as far as Stimers recommended in taking over shipyards and paying workers directly. In mid 1864, however, the Navy reduced the reservation from the original 25 percent to 16 2/3 percent and paid the Tippecanoe-class contractors the difference of $38,333.33 (8 1/3 percent). The Navy also began to pay for the changes, giving each contractor $54,000 in March 1864 and $46,000 in August 1864, with other payments for extra work keyed to individual ships' state of completion.[62] Unfortunately, by

the time these payments were made, the ships were already long overdue and the contractors were too much out of pocket to catch up.

The contractors were also inextricably committed to the monitor program. "I have already expended on the 'Tippecanoe' from one hundred and twenty five, to one hundred and thirty thousand dollars in 'extras,' and have received only forty four thousand dollars of this amount in return," Greenwood told Admiral Gregory in July 1864. In addition, Greenwood noted, he had had to devote his establishment to the vessel, "to the entire exclusion of my legitimate business." Greenwood had so much invested in *Tippecanoe* that he could do little else. The same was true of Snowdon & Sons; John N. Snowdon opined, "I could have got as much money for building a half dozen oil engines as we got for building the *Manayunk*'s machinery." The Secors said the same; building monitors "unprofitably encumbered" their yard and kept it from other work.[63]

In contrast to monitor builders, other specialty producers thrived during the war. The Baldwin Locomotive Works combined "greenback[s] and strong demand . . . [to turn] inflation to its own advantage." In mid 1862, Baldwin stopped giving credit to its customers, and by 1863, it was building locomotives only on a cost-plus basis.[64]

Civilian production had many advantages, which shipbuilders knew as well as anyone. Stimers noted that Harlan & Hollingsworth hesitated to take a Navy contract because private business gave them all the work they could do at favorable prices, while freeing them from the "many annoyances attending a contract with the Government." Among other things: "They work entirely from their own plans and all the little details are made in accordance with their own long habits and those of their workmen. There are no inspectors to direct and interfere with every part."[65] Locked into large, long-term government contracts and unable to pass along price increases, shipbuilders lost the flexibility essential for success in specialty production.

The economic environment buffeted the shipbuilders from every direction. Yet the original contracts envisioned the Tippecanoe class being completed by March 1863. Had the program followed that timetable, the shipbuilders could have finished their ships before the inflation, payment delays, and material and labor shortages of 1863–64 came about. For short-term projects supported by progress payments, any of the

monitor contractors would have had enough capital to survive. The delays incident to continuous improvement stretched out construction dramatically and allowed inadequate capitalization to cripple the monitor program.

The problem of continuous improvement was systemic, a result of the intense urgency that permeated the ironclad program from its inception. Under the stress of war, the Navy had accelerated the acquisition process to the point where contracts for the Passaic class were let before the ships' detailed design was completed. Ericsson's design for the Passaics, however, was reasonably mature, and he himself had a great capacity for work. The combination allowed him to keep the design just far enough ahead of the ships' actual construction to avert costly, time-consuming work stoppages and to minimize late ordering of materials. The lack of battle experience during the summer of 1862 kept the Navy from learning much about monitors under fire, but that lack of lessons learned also minimized the number of combat-driven design changes. As a result, the Passaic program skirted the edge of failure but never quite fell in.

In the harbor and river class, the urgency that drove the Navy's ironclad program became counterproductive. Construction contracts were let when the design was barely past the concept stage, after which it underwent considerable evolution. Ericsson had turned his attention to the seagoing monitors and Stimers focused his efforts on finishing the Passaics, so neither man could give the harbor and river design the concentrated attention it needed. The initial lack of detailed plans and the major redesign of December 1862 markedly slowed construction, which made the harbor and river class more vulnerable to the changes that emerged from the combat experience of 1863. Those changes, in their turn, further slowed construction. Slow construction made contractors more vulnerable to inflation and reduced their cash flow, slowing construction still further, and the longer the ships spent in the shipyards, the more changes accumulated. In a sense, the harbor and river program never recovered from its premature birth.

CHAPTER 8

The Sudden Destruction of Bright Hopes

The Downfall of the General Inspector

By February 1864, the troubled harbor and river monitor program was at last beginning to show results. Although a year overdue, the eastern-built *Canonicus, Saugus,* and *Tecumseh* were nearing completion, and the *Manhattan* was close behind. The last of the eastern ships, the *Mahopac,* was almost ready to launch. West of the Alleghenies, construction continued more slowly, beset by steadily rising prices and a shrinking labor pool. Like the *Mahopac* in the East, the *Catawba* and *Oneota* were nearly ready to launch, but neither the *Manayunk* nor the *Tippecanoe* was close enough to predict a launching date with any certainty. Of the western builders, Swift & Co. had made the most progress, followed by Snowdon & Mason, although both had also undertaken light-draft monitors.[1] Both were ahead of Greenwood.

This improving state of affairs encouraged Stimers to address Fox with a proposal, probably long in the making, to create a new Navy Department bureau: the Bureau of Iron Clad Steamers. The new bureau would be headed by "a practical and scientific engineer especially skilled in the construction of Iron Clad Steamers." The chief would have a staff of thirteen, including an assistant, five draftsmen, and five clerks.[2] Stimers's proposal would, in effect, institutionalize the monitor project office and make it permanent.

The monitor program had been significantly advantaged by the general superintendent of ironclads' project office organization, which offered the potential for better design, better construction management, better alteration management, better logistics support, and better oppor-

tunities to integrate all facets of the ironclad program. In many important respects, the general superintendent's organization prefigured the archetypally successful Special Projects Office that developed and deployed the Polaris Fleet Ballistic Missile system in the 1950s and 1960s.

First and most basically, the monitor project office had a single focus: monitors. Unlike the bureaus of Construction and Repair and of Steam Engineering, which were responsible for everything from contract-built river gunboats to Navy-yard-built cruisers, the general superintendent had a limited area of concern. The project office could concentrate its efforts, as it concentrated initially on providing ironclads quickly and in quantity. The Passaic class represented a very aggressive program of concurrent development and deployment, and the project office succeeded in producing serviceable ironclads in minimum time. As a single-focus organization, the project office could also be highly responsive to the concerns of the Navy's leadership. This appears not only in Stimers's relationship with Fox but in the energy and inventiveness displayed in preparing Du Pont's ironclads for his attack on Charleston and in modifying them afterward.

Second, the monitor project office controlled the design details of its ships. Under normal conditions, a ship built by one bureau would be engined by another and armed by a third. If each bureau optimized its own systems with insufficient regard for how they fitted together, or if the three coordinated their efforts imperfectly, the effectiveness of the ship as a whole would be lessened. With a single agency responsible for all parts of the vessel, everything could be integrated to obtain the best overall design.

Third, the monitor project office was uniquely well placed to provide integrated logistics support for its ships. Its centralized technical management gave it much more control over the ships' configuration than was common at the time, which meant that the ships could reasonably be expected to match the drawings on file at the project office. This, in turn, allowed the development of alteration kits, like the pilot house sleeves or the turret base rings, that reduced the time and effort needed in the field to perform alterations. Similarly, common designs and readily available drawings eased the problem of providing repair parts to deployed monitors. Involvement in every stage of design and construction allowed project office personnel to become "monitor specialists" and

enabled the general inspector to provide experts to alter and repair ironclads on station.[3] Well-trained personnel, intimate knowledge of requirements, and close relations with contractors allowed such highly successful fleet support operations as the Port Royal Working Parties, their Hampton Roads counterpart, and the *Weehawken* repair team.

Fourth, all of the complaints about the monitors were funneled to the project office, either directly or through Fox, providing invaluable feedback. "I like to hear their faults, because it teaches a lesson—Praise never does," Fox wrote Ericsson.[4] Despite the division between builders (engineers) and operators (line officers), and despite Ericsson's prickly attitude toward critics, feedback from the fleet resulted in alterations such as those that strengthened pilot houses and turrets, reduced leakage under turret bases, improved ventilation, and increased the ships' capacity to cope with flooding.

There were, however, drawbacks to the monitor project office form of organization, including the volume of work the office took on and the lack of independent technical review of its engineering decisions. The drawbacks stemmed from a combination of Stimers's personality and the ambiguous position of the project office in the Navy's organization.

The volume of work assigned to or claimed by the project office grew dramatically in 1862 and 1863. Originally conceived as a production-oriented inspection organization, the office expanded to fill all the niches that opened in the monitor program. When Ericsson became too busy to design the harbor and river monitors, the project office took over to turn the master's general plans into detailed drawings. When the deployed monitors required alterations and repairs, the project office organized and managed the work and the workers. When the design of the light-draft monitors stalled, the project office took it over. Stimers even designed a "fast sloop-of-war," to be called the *Mercury*.[5] Coupled with temporary assignments to Port Royal and the demands of the court of inquiry that Du Pont instigated, the project officer's workload was killing. Stimers could not do it all and still do it correctly.

Yet flaws in the general inspector's character kept him from seeking assistance. Jealous of his turf and ambitious for advancement, he would not turn to the established bureaus for assistance and in fact rebuffed them whenever he could. Neither would he ask Ericsson for help, at first because of what he perceived as Ericsson's egocentric resistance to "any

other than himself" designing monitors and later because he saw himself competing with Ericsson as a designer.[6] Finally, a quarrel over the Tippecanoe-class gun mountings led to an overt break between Stimers and Ericsson. Stimers became trapped in the cycle of overwork and cutting corners that may be characterized as "There's never time to do it right but always time to do it over."

Aggravating Stimers's rejection of bureau assistance was the attitude of the bureau chiefs themselves. Stimers had gained practical independence from the bureaus of Construction and Repair and of Steam Engineering, and the bureau chiefs, in turn, washed their hands of Stimers's designs. While the independence and hand-washing gratified the egos of those concerned, they removed an essential element of an effective project office system: the second look. On the policy level, no one in a position of responsibility proposed alternatives to the monitors after Hampton Roads. On the technical level, no one double-checked Stimers's designs or Allen's figures; no one calculated the trim of the harbor and river monitors or the displacement and weights of the light-drafts. No competing subagencies honed the designs by providing critiques of their competitors' analyses, pointing out flaws or generating technical alternatives.[7] To be effective, a project office must have enough autonomy to make decisions concerning its assigned project, but basing those decisions upon a single source of technical information and opinions is not sound management. Stimers succeeded so well in getting outside the system that he gave up the safety net that a second technical opinion might have provided.

Stimers's campaign for autonomy also illuminates the most serious flaw in the Navy's ironclad acquisition system: its management structure, and, more precisely, the imbalance between the service's formal and informal organizations. Formally, Stimers's job was to ensure that the monitors being built met the specifications that others had prepared —a very responsible assignment, but not one calculated to make an ambitious man stand out from his contemporaries. Informally, Stimers ruled the monitor program from design through construction to in-service repairs.

Stimers thus exercised influence far out of proportion to his station, influence that he owed purely to his relationship with Fox. Fox had caused the secretary of the Navy to create Stimers's position and to order Stimers

to the job; he could as readily remove Stimers and assign someone else as general inspector. Stimers also knew that the general superintendent's office was a wartime expedient; when the war ended, it would surely be abolished. Stimers responded to the insecurity of his too highly exalted position with exaggerated touchiness and hunger for autonomy.

Stimers viewed the bureau chiefs as rivals, and their relative position aggravated his insecurity. Unlike the general superintendent's organization, the bureaus were permanent and established by law. Unlike the general inspector, the bureau chiefs had been confirmed in their positions by Congress and could not be dismissed lightly. Isherwood and Lenthall thus had a much more secure institutional base than Stimers—and when the war ended, they would retain their high status, while he would return to relative obscurity. Although the bureau chiefs had little practical authority over the ironclad program, Stimers perceived their latent formal authority as a constant threat. To defend his program and his position, he chose to try to crush his opponents rather than to co-opt them.

Because he owed his highly influential and visible position entirely to Fox, Stimers would do nothing to jeopardize the relationship that made it possible—as the saying goes, if the elephant wants peanuts, feed the elephant peanuts. Stimers's dependence upon Fox colored the technical decisions he made, as shown by his redesign of the Tippecanoe class and his eagerness to gratify Fox's desire that every monitor be 100 percent up to date when she left her builders' hands. It is quite possible that a bureau chief, more secure in his position and in his direct access to the secretary of the Navy, would at least have discussed such issues and might have objected to some of the less defensible courses the monitor program took under Fox's influence—a bureau chief would not have had so much incentive to feed the elephant peanuts. A permanent, formally established project office (such as the Bureau of Iron Clad Steamers) might have helped to ameliorate the delay and disruption caused by the continuous improvement philosophy.

The Bureau of Iron Clad Steamers legislation that Stimers proposed was very general, perhaps deliberately so. It did not clearly define the administrative boundaries between the proposed new bureau and the existing ship acquisition bureaus (Construction and Repair and Steam Engineering), presumably to sidestep controversy that might harm its chances of passage. In his letter to Fox, Stimers discussed only Construc-

tion and Repair, saying that while Lenthall was in no way incompetent to perform his proper duties, "I think that nothing has ever been more thoroughly demonstrated than that he is unequal to the task of the production of an iron clad vessel." Reminding Fox that Joseph Smith's Bureau of Yards and Docks had built the first ironclads over Lenthall's opposition, he asked rhetorically, "Afterwards when the demand upon the Bureau of Construction was imperative, what did it produce?" Yet Lenthall was needed, Stimers wrote, because "where one iron clad is being built several wooden ones are projected," a state of affairs that would likely continue "for many years to come perhaps always." The "true remedy" would be a new bureau "devoted especially to this subject."[8]

Many would have opposed the creation of such a bureau, based on bureaucratic turf, professional and personal animosity toward Stimers, and line officer resistance to a second bureau run by an engineer, but the proposal's demise was by no means foreordained. In its 1862 reorganization, the Navy had acknowledged the need to institutionalize new technology, and the Bureau of Steam Engineering was the result. A similar move to institutionalize another new technology seemed distinctly possible.

Stimers's proposal to revamp the management of the monitor program helps to confirm the hints given by his proposal to pay shipyard workers directly and by the negotiation system of ordering changes: the Navy had belatedly begun to perceive that technology was no longer the most important issue in the monitor program. Ironclad technology was, in fact, fairly well in hand—better management and contracting practices were what the program needed now.

Three months before his bureau proposal, Stimers had recommended that he be made engineer-in-chief of the Navy as a very public way of answering a *New York Times* editorial attack on his competence and character.[9] Although he certainly saw himself at its head, his Bureau of Iron Clad Steamers was much less overtly self-serving than his (apparently serious) proposal that he be made engineer-in-chief. Given the chance, the Bureau of Iron Clad Steamers could have corrected a number of problems. By reintegrating the ironclads into the Navy's bureau system, it would have enforced cooperation among the Navy's technical bureaus, or at the least ensured that controversies between them would reach the secretary of the Navy for explicit resolution. By aligning the Navy's formal and informal organizations and formalizing the general inspector's

informal control of the ironclad program, it would have removed much of the insecurity that drove Stimers's quest for autonomy.

That autonomy had taken a blow in the autumn of 1863 when Admiral Gregory rescinded Stimers's authority to correspond directly with the contractors, and Fox had refused to intervene. The general superintendent evidently kept a close eye on his ambitious subordinate, and as it turned out, he had reason to be suspicious. When Stimers's attempt to regain full control of the ironclad office's correspondence failed, the engineer decided to evade Gregory's order. Although he could not instruct the contractors without going through Gregory, he reasoned, he *could* direct the government inspectors at each contractor's shipyard and have those inspectors direct the contractors.

By the end of October 1863, this dodge had come to Gregory's attention. The admiral delivered a strong rebuke, writing that he considered it "an evasion of the orders of the Department of which I cannot approve."[10] In essence, Gregory told Stimers that he expected him to follow the procedures for dealing with contractors both in letter and in spirit.

This was not the first time that Gregory had shown impatience with Stimers's autonomy. When the war began, the old sailor had sought command at sea but was denied; his promotion to rear admiral on the retired list brought him little pleasure, accompanied as it was by shore duty.[11] Gregory had been in the Navy for over fifty-two years and had been a captain for twenty-four by the time he became general superintendent of ironclads in 1862. At that time, Stimers had served for thirteen years and had been a chief engineer, equivalent to a line commander, for less than four. A less dedicated man than Gregory could readily have allowed himself to be consumed by resentment of the amount of influence wielded by an officer so junior to him, and an engineer at that. It is to Gregory's great credit that he worked so well for so long in such an uncomfortable position relative to his nominal assistant.

By the autumn of 1863, though, Gregory's tolerance had begun to wear thin. In part, this was from overwork, the strain of intense effort on a frame that had already exceeded its allotted three-score years and ten. Gregory wrote Fox in June 1863 that he was "a very tired mortal," and on several occasions the general superintendent had to curtail his activities due to illness. Stimers's duties included monitor ironclads only, but Gregory's responsibilities extended farther. Other programs, such as

gunboats, required his attention. "The Side Wheelers are hatching out, like a brood of young ducks, all quacking for something to be done for them," he wrote in April 1863.[12]

In larger part, however, Gregory had probably become impatient with Stimers's constant efforts to enlarge his own authority and autonomy. Despite the initial intent that Gregory would manage the personnel of the inspectorate, Stimers had added that task to the inspection, design, alteration, and repair duties already mentioned. Stimers exercised great influence over the assignment of naval engineers, both to positions in the inspectorate and to duties afloat aboard the monitors. In this context, for example, Gregory noted in April 1863 that he had too few engineers, but, "I have been shuffling along, waiting for General Stimers' return to have the ranks filled."[13]

Stimers had already turned back one challenge to his authority, at the cost of publicly embarrassing Gregory. In early June 1863, Chief Engineer James W. King wrote Fox of his "considerable anxiety" about the western-built monitors and suggested that he could be "much more valuable as Supervising Engineer for all vessels under construction on the Western Waters." Fox consulted Gregory, who opined without asking Stimers that such an arrangement would bring many advantages. On June 26, Gregory appointed King "Genl. Insp. of all the Iron Clad Vessels now under contracts at St. Louis, Cincinnati, and Pittsburgh," reporting directly to Gregory.[14] Stimers reacted strongly, traveling promptly to Washington "under considerable excitement" to talk to Fox. Stimers convinced Gregory that "a joint of his tail had been cut off, occasioning considerable agony." Although Gregory continued to support the idea of a general inspector for the western-built vessels, he advised Fox that Stimers's "affection for the monitors is so intense—that he cannot bear the least interference with whatever concerns them" and recommended that Fox gratify Stimers for the sake of the latter's happiness and efficiency. Gregory soon received an order that defined King's position as subordinate to that of Stimers, so the admiral had to revoke his orders to King.[15] Despite his assertion of indifference, one suspects the episode chafed Gregory.

Stimers had also become accustomed to having his own way in technical matters. In October 1863, a board of officers reviewed the anchor arrangements of the Tippecanoe class and decided that only one of the two anchor chains could be protected by armor. Stimers, the minority in a

two to one decision, disagreed with the board's findings and refused to apply them, whereupon Gregory unequivocally directed compliance in another strongly worded letter. Fox's failure to restore Stimers's authority to correspond directly with contractors, combined with Gregory's two strong letters, should have warned Stimers that he was overreaching—that his influence was no longer waxing.[16]

In this climate, Fox received Stimers's proposal for a Bureau of Iron Clad Steamers. The assistant secretary does not appear to have commented upon it immediately. One reason was probably that the Tippecanoe-class ships, despite their recent progress, were still a year overdue and already hundreds of thousands of dollars over budget. Another reason was that Stimers's other major construction program, the light-draft monitors, was also overdue and over budget.

The light-drafts, ordered in the spring of 1863, were the last monitors for which the Civil War Navy contracted. In mid May 1863, Stimers had recommended building one more harbor and river monitor to make a round ten of the Tippecanoe class and no more than twenty light-drafts, because, "Even this number disturbs the prices of both labor and iron by carrying the demand considerably above the supply." Welles concurred with these second thoughts, for Fox told Stimers in early June 1863, "We have given out 20 light drafts and that ends the list. The Secretary has decided not to build any more monitors excepting the 15 inch double turret ones in the Navy Yard."[17] In the event, the twenty light-drafts did more than disturb the prices of labor and iron. They toppled Stimers, mortified Fox, embarrassed Welles, and set the Navy's acquisition system back for decades.

Ericsson's original conception of the light-drafts included a simple iron hull surrounded by a ram-proof wooden raft and moved by the simplest possible machinery, but his original goal of quickly obtaining a light-draft ironclad got lost in Stimers's quest for a technically elegant design. After the general inspector finished "gold-plating" them, the light-drafts were much larger and more complex than Ericsson had intended and would take far longer to build than the ninety days he had estimated. To speed production, the Navy planned to provide an outline and specifications and allow each contractor to develop his own detailed design. Stimers introduced such complex specifications, however, that the technical and financial risks deterred contractors from making their

own plans.[18] Waiting for the Navy's plans further delayed the builders, and the ships that Fox hoped to have in service in the autumn of 1863 were still under construction six months later. Then, in the spring of 1864, a crisis arose in the North Carolina sounds that in turn precipitated a crisis in the monitor program.

This study has not addressed Confederate ironclad construction, but it continued throughout the war, albeit at a pace limited by the Confederacy's underdeveloped metalworking industries and inadequate transportation system. After an unsuccessful strategic "first phase" of home-building ironclads intended to break the Union blockade, the Confederate Navy entered a "second phase" in which harbor defense was paramount. Although the second phase, like the first, included seagoing ironclads to break the blockade and fast cruisers to prey on Union shipping, both these types of second-phase ships would be built in Europe. Home-built ironclads would operate in coastal waters as moveable forts, their primary mission being local defense.[19] One such home-built ironclad was the CSS *Albemarle,* under construction on the Roanoke River at Edwards Ferry, North Carolina.

The *Albemarle* was laid down in late 1862 and made halting progress over the next year and a half. As the ironclad neared completion in the early spring of 1864, Union leaders reacted with concern to the threat posed to their control of North Carolina waters. The Confederate ram—mechanically unreliable, slow, and poorly armed and armored—would stand little chance against a monitor. Unfortunately, monitors drew too much water to enter the shallow North Carolina sounds. Even the Passaic class needed 10 to 12 feet in which to float, while the *Albemarle* needed only 6 feet. Tidewater North Carolina was exactly the sort of area for which the light-draft monitors had been designed—but none of the light-drafts were finished yet. None had even been launched.

Fox was already concerned about the delays. Stimers's proposal for a Bureau of Iron Clad Steamers arrived on his desk at about the same time as a complaining letter from Nelson Curtis, whose Atlantic Works was building the light-draft *Casco*. The two combined to elicit a most revealing cri de coeur from Fox. Curtis's letter, Fox wrote in late February, "foreshadows delays, those horrible bills for additions and improvements and everlasting alterations, all of which have cursed our cause and our Department." More than melancholy, he told Stimers, the delays

were fatal—"fatal to the iron-clads, to the monitors, to the establishment of any proposition such as you have presented." The light-drafts would not be done for the summer campaign, "though six of them would have given us the vitals of the South. What is the reason?—additions, alterations and improvements."

Asserting that the Navy should have "taken a lesson from the rebels and put our vessels together cheaply and simply," Fox summarized the damaging effects of continuous improvement on the monitor program in a letter to Stimers:

> The first monitor did more than all the others put together, because she was in time, and if the Department had made no attempts to improve her, for which I take all the blame, but had confined itself to repeating such a cheap class of admirable vessels, what success would have crowned our efforts! Now I repent in bitterness of disappointment, more especially as everything I hear from the light-drafts is, that they are coming out fine made vessels, but alas! too late.[20]

He went on to say that the "wish of my heart" was for twelve copies of the original *Monitor* and twelve light-drafts, "upon which not a single alteration, addition or improvement had been added." Although the reasons for the delays and cost overruns might be clear to the professional mind, "to us it comes like the sudden destruction of bright hopes." Sending Stimers's proposal for a new bureau to Congress would only result in another congressional investigation. Fox blamed himself for the everlasting alterations, "because I could and ought to have prevented it."[21]

Despite Fox's apportionment of blame to himself, Stimers felt the rebuke keenly. He had just learned that the new gun-carriage recoil absorbers Ericsson had designed for the Tippecanoe class had failed under test, which had made Stimers "so very blue that your [Fox's] letter could depress me no further." Stretching hard to find a silver lining, the general inspector reflected that because Southern ports were filled with mines and obstructions, the ironclads could do very little toward shortening the war even if all were completed. The ships had already prevented European intervention, and since the Union might still have to fight European navies, "we may yet be thankful that we did not impair the efficiency of these new and powerful vessels" by attempting to enter Southern ports with them.

Besides this strained attempt to put the best face on construction delays, Stimers told Fox that the cost of the improvements was small compared with the efficiency they would add. He again pressed his bureau proposal, writing that it would remove most of the difficulties and save bitter disappointments in the future. Although grateful for Fox's "nobleness" in taking the blame for delay, Stimers wrote, "as you followed my advice with regard to the vessels *building* this removed none of the sting." Almost buried in Stimers's letter was the admission that he and Ericsson had differed over the gun carriages of the Tippecanoe class, causing "a difficulty . . . which will I fear prevent any further personal intercourse between us."[22]

Sometime in early March 1864, Stimers and his assistant Theodore Allen went to Boston to take charge of the building of the light-draft monitor *Chimo* and hurry her to completion, probably because of Fox's concern about the almost-completed *Albemarle*. Allen later recalled that they could not obtain labor in Boston even by paying higher wages than the neighboring yard, and they had to import skilled workmen from New York.[23] There was much to do, and the *Chimo* was not yet launched when CSS *Albemarle* was commissioned on April 16, 1864. After an engagement with Union gunboats on April 19, the *Albemarle* supported General Robert F. Hoke's troops on April 20 in capturing Plymouth, North Carolina.

The resulting uproar shook the Navy Department. Since the light-drafts were still not ready, Fox entreated Ericsson to develop a system of "camels," or pontoons, to lift a Passaic-class monitor enough to enter the Sounds and engage the Confederate ironclad. This scheme came to nothing.[24] The *Albemarle* set off for New Bern, North Carolina, but on May 5, 1864, she was engaged by several wooden Union gunboats and driven back to Plymouth. The redeployment of Confederate troops to meet Lieutenant General Ulysses S. Grant's attacks in Virginia brought an end to Confederate plans to seize New Bern, but this was not immediately apparent to the Union. The *Albemarle* remained at Plymouth to defend the town and to threaten Union control of the sounds, and Fox and Stimers continued to force the completion of a light-draft monitor to meet the threat and help retake Plymouth.

March and April 1864 had been difficult months for Stimers, during which he had little correspondence with Fox. What he did have was un-

pleasant. Fox wrote in late April railing about bad inspection on the light-draft monitor *Naubuc*. "Not an inspecting engineer has been reported for passing bad work," he asserted, "yet not a vessel has gone out that has not been grossly neglected." Stimers replied that the charge was an injustice; he had no time to answer in detail, but wrote because he supposed Fox would regard silence as a confession of delinquency.[25] His relationship with Fox, based largely on Fox's view of Stimers as a man who got things done, was clearly in jeopardy. The progress on the harbor and river monitors was good news, but it was tempered by the knowledge that it was more than a year overdue.

After much exertion, Stimers and Allen managed to get the *Chimo* down the ways on May 5, 1864. At that point, Stimers's prediction of bitter disappointment began to come true, albeit in a different way than he had expected. The newly launched ship, still without her turret, pilot house, guns, ammunition, coal, or stores, had 37 inches of freeboard forward and 19 inches aft. As Aquila Adams, her builder, later noted, "it was thought that she drew more water than was anticipated, but they had not sufficient data at that time to tell positively." As Stimers pushed the vessel on toward completion, data accumulated, and the first official notification of the problem appears to have come on May 31, when Gregory advised Welles, "It is a matter of doubt whether she will prove an efficient vessel, in consequence of the great draft of water."[26]

"Great draft" was an understatement. When equipped for combat, the light-draft monitors would not float.

Once completed and loaded with all their coal, stores, and ammunition, the light-drafts were intended to have 15 inches of freeboard. Upon measuring the *Chimo* with only part of her coal and no ammunition on board, Adams found that she had 8 inches of freeboard at her bow, but her stern was 3 or 4 inches under water. Adding the ammunition would have made her deck level with the water or submerged it. Only the arched portion of the deck along the ship's fore-and-aft centerline would have been out of the water—"rather a small margin for a man to go to sea with," observed the naval constructor W. L. Hanscom, who found the stem 7 inches above water and the stern 1 inch below water when he measured the *Chimo*.[27] The *Casco,* launched shortly after the *Chimo* by Adams's competitor Curtis, displayed the same excessive draft. Not only

were the light-draft vessels far behind schedule, but when completed they would very likely sink. The millions spent for the twenty light-drafts had been wasted.

The consequences of the failure spread widely. For Stimers, the blow was professionally fatal. He wrote privately to Fox on May 31, 1864, again straining hard to put the best face upon matters. Alluding to past successes, he observed, "The Light Drafts will have to do as the other Monitors have done—fight their way into favor." Grasping at straws, Stimers resorted to "ifs": "If they were six inches more out of water . . . they would be decidedly the best vessels we have for this war."[28]

Stimers found those inches of additional freeboard to be beyond his reach, and events began to move quickly as the magnitude of the problem became evident. The difficulties were twofold: how to deal with the technical matter of ships that would not float, and how to deal with the political fallout of a multimillion dollar mistake. Gregory visited Washington on June 3, 1864, where Fox advised him to consult with Chief Engineer James King, Chief Engineer William W. W. Wood, and First Assistant Engineer Isaac Newton, and then to discuss the matter with Ericsson. Fox wrote Ericsson to ask him to help make the light-drafts serviceable, help Ericsson agreed to give.[29] Fox's request led to a meeting at Ericsson's house, sometime between June 4 and 7, among Gregory, King, Ericsson, and Stimers.

Stimers was already in New York, having traveled from Boston to call upon Ericsson. Upon his return to Boston on June 8, he wrote Fox that he had tried to repair his relations with Ericsson but that the inventor rebuffed him. Stimers asserted that Ericsson's claim to have been insulted was "only an excuse to enable him to do everything in his power to crush what he chooses to consider a formidable rival"—namely, Stimers himself. During the hour and a half visit, Stimers wrote, he was impressed by Ericsson's intent to bring Fox to grief because Fox had allowed someone other than Ericsson to design monitors. Ericsson, according to the general inspector, decried Fox's "utter incompetency"; the inventor was "strongly committed" to the failure of the light-drafts and would "stoop to anything under Heaven which he considers would not disgrace him" to ensure that Fox would be disgraced and Stimers "utterly annihilated."[30]

Stimers then wrote of the meeting with Gregory, King, and Ericsson,

reporting that, "after some squirming about," Ericsson had said he could not express himself fully in Stimers's presence. Stimers attributed this to Ericsson's desire to undercut him, but since the gathering was held at Ericsson's house, he had to depart. Although he had not heard the result of the conference, Stimers wrote, he foresaw "that the vessels were to be ruined and that great amounts of money were to be expended in making the changes necessary to ruin them." Accordingly, he worked out a plan to alter the unlaunched light-drafts to carry "all the weights originally intended or rather without removing weights to affect the draft" with 18 inches of freeboard.[31]

Stimers felt himself to be in desperate straits, and he resorted to desperate measures to preserve himself. His letter of June 8 seems to have been an attempt to drive a wedge between Ericsson and Fox. It attributed to Ericsson a degree of hostility and bitterness toward Fox that based on the record simply did not exist. It also attempted to discredit in advance any technical solution that Ericsson might put forward. Finally, it promised wonderful things of Stimers's own design. "Stimers and Fox against the world again," was the unspoken message. "Stick with me because I can deliver."

The messages Fox (and Welles) received were different, the political intersecting with the technical. The failure was technical—miscalculation of a cumbersome but basically simple problem in hydrostatics—but the result was also political. The ships might be made useful, but whatever technical remedy the Navy chose, it would cost a great deal of money and time and would lay the Navy Department open to attack from enemies such as Du Pont and his partisans. Although Fox privately took overall responsibility for the monitor program, he was a political appointee and not a technical expert. Stimers was that expert, and it was he who had elaborated the light-draft design and assured the assistant secretary that it was technically sound. As the responsible party in a technical failure of such magnitude, Stimers would clearly have to suffer serious professional consequences. Stimers's intemperate letter of June 8 probably hastened rather than retarded his departure.

Welles sent Fox to Boston to see the two light-drafts himself, telling him to consult with Gregory before returning. Welles wanted prompt measures to remedy the mistakes, which he called "serious miscalcula-

tions—an attempt to get too much in too small a space." There was now, Welles wrote, "no alternative but to do what is possible," and Stimers "must not be tenacious in holding on to admitted errors."[32]

Stimers returned to New York sometime after June 10 and went from there to Washington on June 14, 1864, to present Fox with his plan to fix the light-drafts. He heard just before he arrived at the Navy Department that he had been removed from the office of general inspector and replaced by Chief Engineer Wood, but interpreted Fox's comments during their meeting to mean that the office itself had been abolished, that there would be no general inspector. When he arrived back in New York to find that the office still existed and that Wood had been appointed to it, Stimers's prickly temper and suspicious nature showed again. Wood's conduct was insulting, Stimers wrote, and Wood had been working industriously for over a year to undermine him; accordingly, Stimers could not work under Wood. Displaying a noteworthy element of wishful thinking, Stimers proposed to salve his ego by dividing the general inspector's responsibilities: since there was no complaint against the Tippecanoes, Stimers could supervise those ships while Wood took over the light-drafts.[33]

Besides writing to Fox, Stimers protested to Gregory that the Navy Department's order had meant to abolish the position of general inspector in name but leave Stimers in charge of the monitor program in fact. Gregory asked Fox for clarification, saying that Stimers claimed the order was intended to "house his horn of 'General Inspector' in the present squall of disappointment, and leave him still to direct the Iron Clads by the *tail*—instead of the head as heretofore." Gregory viewed the Navy Department's order as removing Stimers, not removing the position. Fox confirmed Gregory's interpretation, and on June 17, the axe finally fell, and Wood relieved Stimers. In the interim, Stimers had characteristically continued to act as general inspector.[34]

With Stimers gone, the position of general inspector lost the autonomy and influence it had had for the preceding two years. The imbalance between formal and informal organizations was thus redressed by lowering the general inspector's informal status rather than by raising his formal status.

One reason for Stimers's downfall was the progress of the war. In the anxious days of 1862, the Navy's leadership had seen the monitor pro-

gram as vital to the survival of the nation. When Stimers became general inspector that year, ironclad construction was the Union Navy's top priority. Ericsson understood the urgency, and the Passaic class, built to his design in an atmosphere of intense pressure, struck an acceptable balance between technical refinement and quick production. Stimers, however, had a less balanced appreciation than Ericsson, and his stress on technical improvements led to serious delays. Those delays in turn undermined the urgency of the program.

In 1864, the monitors were still not finished, but the delays had not caused disaster—even without the ships, the nation had survived and was gaining the upper hand over the Confederacy. The ironclads that seemed so vital in 1862 thus seemed much less so in early 1864, and the desire to complete them was correspondingly less intense. As the perception of urgency declined, so did Stimers's ability to manage outside the system. Eventually, the pressures created by delay, cost overruns, and technical failures grew great enough to destroy confidence in Stimers's ability to manage the monitor program at all and to overcome Fox's commitment to outside-the-system program management.[35]

Firing Stimers did not, however, change the situation in the shipyards. By mid June 1864, the Navy had completed four of the Tippecanoe class; three more were afloat but two had not yet been launched. Three light-drafts (the *Chimo, Casco,* and *Tunxis*) had been launched, but work had been ordered stopped on the other seventeen while the Navy decided what to do with them. Ericsson joined in the effort to save the light-drafts, and the ships were modified in two ways. The *Casco, Chimo,* and three others were finished as torpedo boats, with reduced armor and no turrets, although with a top speed of 5 knots they were not much use for torpedo work. The sides of the others were extended nearly 2 feet to deepen the hulls and give them enough buoyancy to carry their two 11-inch guns without sinking. Both Swift and Snowdon altered their light-drafts in this way, at an average cost of $84,000 per ship, and the changes delayed each vessel several months.[36] Meanwhile, the menace of the *Albemarle* had been addressed in a fashion that—embarrassingly enough for Fox and Stimers—had nothing to do with monitors, light-draft or otherwise. In a daring attack on October 27, 1864, Lieutenant William B. Cushing sank the Confederate ironclad with a spar torpedo mounted on a steam launch.

With so much public money involved, Stimers's professional demise proved insufficient in itself to head off criticism. The powerful Joint Committee on the Conduct of the War investigated the episode, one of the few wartime congressional investigations of the Navy. The joint committee found the proximate causes of the failure were the use of green timber; miscalculation of weights and displacement; and "additions and alterations made in the plans."[37] Theodore Allen, who had actually made the calculations, may have made computational errors as well. Allen took a good deal of blame for his mistakes, but the committee faulted Stimers for his failure to check Allen's work and faulted the Navy Department for ordering so many ships to the same plan without building a prototype.

The underlying difficulties, however, were those we have examined. When the ships were designed, Stimers's desire to please Fox and his urge to create the best possible ship led him to overcomplicate and overload the vessels. Afterward, Stimers himself was too overloaded with work to take the time to verify Allen's calculations, and there was no technical second look to ensure against error.

During the 1865 hearings, Stimers asserted that he had consulted with Ericsson, Lenthall, and Isherwood and that he had asked Lenthall to verify Allen's calculations, which Lenthall had refused to do. Isherwood and Lenthall, he claimed, "did not believe in ironclads, and especially in the monitors . . . they were opposed to the whole thing, and lent no assistance to it." Stimers testified: "I always felt that it was a regular fight—that we had to conquer [the bureaus] before we could get them to do anything." Stimers tried hard to dissociate himself from the plans, claiming, "Of all this work it was held that Captain Ericsson was the designer, and I the general inspector, until the light-draught monitors were accounted failures, when it was published throughout the country that I was the designer of them."[38]

This self-serving testimony shows Stimers at his worst, doing his utmost to squirm out from under the responsibility he had once been so eager to acquire. Ericsson's letters to Fox make it clear that Ericsson had little part in the evolution of the light-draft design, and Stimers's correspondence shows that he claimed the light-draft design as his own until the failure of the vessels made it expedient to run for cover.[39]

For their part, Lenthall and Isherwood emphatically denied Stimers's

claim that they were inimical to the vessels, and the evidence supports them. For example, Stimers asserted before Congress that Isherwood had refused to provide naval engineers to serve as inspectors, but his own extensive correspondence with Fox about personnel assignments, not only to inspection positions but to duty aboard monitors afloat, belies this.[40] Stimers got at least a fair share of naval engineers for inspection positions, many of whom were outstanding in their corps. Loring, King, and Wood, for example, each went on to rise to the position of engineer-in-chief of the Navy. Fox made Isherwood's lack of influence explicit when he observed that the engineer-in-chief's involvement was limited to having his clerk write the engineers' orders. "I doubt the propriety of Mr. Stimers putting on to Isherwood's shoulders any 'malign influence' against the Monitor fleet," Fox wrote Ericsson.[41] Lenthall and Isherwood had supported ironclads consistently since the "Bureau design" of 1861.

While Isherwood was a controversial figure within the Navy and without, neither he nor Lenthall actively opposed the monitor program. For one thing, Assistant Secretary Fox strongly supported the monitors, and he would have taken prompt and firm action to suppress any resistance or foot-dragging by the bureau chiefs. Another reason was that both Isherwood and Lenthall were loyal to Welles and to the Union cause; they would not deliberately have obstructed either.

To be sure, neither Lenthall nor Isherwood were saints. Both were seasoned bureaucrats as well as technical experts, and while they would not have actively opposed Stimers, they were perfectly willing to let him fail on his own. Lenthall and Isherwood withheld information because Fox and Stimers had slighted them, Welles noted, and when he told the bureau chiefs that they had failed in their duty, they both admitted it. Yet Stimers, whom Welles described as "intoxicated, overloaded with vanity," and "more weak than wicked, and yet not devoid of talents," had also failed in his duty.[42] His failure, and the Navy's failure to develop institutions that could compensate for his flaws, brought the project office system down with him.

Fox's change of heart about additions, alterations, and improvements came too late to make much difference to the shipbuilders—for them, the damage in terms of delay, disruption, and added expense was already done. The *Canonicus* had been commissioned in April, and Harrison Loring was out of the monitor business for good. The *Saugus* also

commissioned in April, leaving Harlan & Hollingsworth with only the light-draft *Napa* in its yard. The Secors commissioned the *Tecumseh* in April and the *Manhattan* in June, leaving them to put the finishing touches on the *Mahopac* and commission her in September (Fig. 8.1).

West of the Alleghenies, the *Catawba* and the *Oneota,* launched in April and May respectively, were well along in their fitting out, and the manpower Swift & Co. devoted to them diminished correspondingly. As the major effort shifted to the light-drafts *Klamath* and *Yuma,* manning on the two larger ships dropped from about two hundred men in March, April, and May 1864 to under one hundred in July. Work on the *Tippecanoe* and the *Manayunk,* which had missed the spring rise in the river, proceeded much more slowly. Swift tested the *Catawba*'s boilers and machinery on October 15, 1864, and in late October, Charles Loring advised Wood that the ship's guns should be sent from Pittsburgh within two weeks.[43] The *Manayunk* was launched on December 18, 1864, and the *Tippecanoe* followed on the same rise of the river on December 22. All nine of the class had been launched, but only eight remained afloat; a Confederate mine had sunk the *Tecumseh* in August 1864.

The *Catawba* and *Oneota* were close to completion, so close that Loring reported that they would go downriver on the December rise to be completed at Mound City. Insufficient water at Louisville prevented this, however, and the ships remained in Cincinnati. Severe cold and frequent snowfalls in January interfered with outdoor work. The drift ice in the river was so heavy that the *Catawba,* moored outboard of the *Oneota,* had to keep steam up for some days in case she needed her engines in an emergency.[44] Slow progress continued through February, but in early March, another seasonal rise in the Ohio River caused a flurry of activity.

When it came, Swift's ships were ready to go. They departed Cincinnati under their own power on March 2, arriving at Mound City on March 7, 1865. The *Tippecanoe* was not so ready, but Greenwood dared not miss an opportunity to take the ship downriver; 1863 and 1864 had seen the shallowest river levels in years, and he could not risk continued low water. The *Tippecanoe* departed on March 10 under tow and arrived at New Albany, Indiana, on March 14.[45]

Farther upriver at Pittsburgh, the *Manayunk*'s departure was even more hurried than the *Tippecanoe*'s. On March 5, a freshet tore the *Manayunk* loose from her moorings, and she drifted some way down river

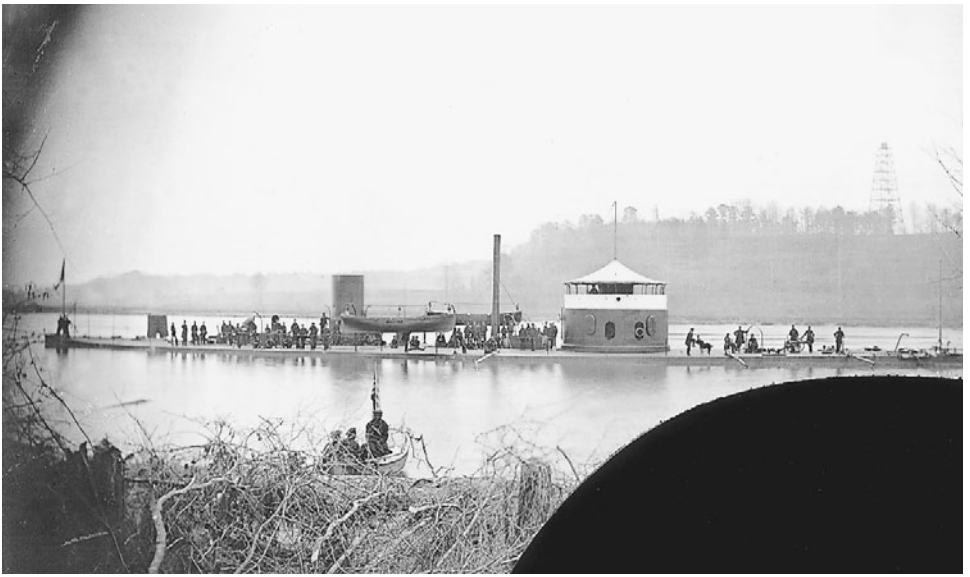


Fig. 8.1. The Tippecanoe-class monitor *Mahopac* in the Appomattox River, 1864. National Archives photograph NWDNS-111-B-409.

before her anchor caught and held her. Two small towboats made no progress against the current, and the larger towboat *Panther* had to return the monitor to her berth. On March 6, the *Panther* again took the *Manayunk* in tow and headed downriver for Mound City, where she arrived on March 11, 1865. Snowdon & Mason had to send some 400 tons of material as freight in addition to paying $7,000 for the *Panther*'s services.[46]

Swift & Co. completed the *Catawba* and *Oneota* in late May, and each vessel made two trial trips. The inspection board, headed by Commodore J. M. Livingston, reported to Gregory that the workmanship was good and the machinery first quality. The vessels were "greatly admired here for their beauty of workmanship, good taste and economy of arrangement." On June 23, 1865, Acting Volunteer Lieutenant Commander Francis S. Wells took charge of the two ships and the contractors' men returned to Cincinnati. Wells moved the vessels some six miles from the Mound City Naval Station to a point where the water was deep enough for their safety, and the Navy took over shipkeeping and security.[47]

The *Manayunk* was the next of the class to be completed. A naval board observed her trial on September 27, 1865, and reported that "all worked admirably." The board opined that the ship was equal or superior to the *Catawba* or the *Oneota,* and she was duly accepted.[48] The workmen who returned to Cincinnati and Pittsburgh probably went to work on the light-draft monitors their firms were building.

In Cincinnati, Swift had launched the *Klamath* on April 20, 1865, and the *Yuma* on May 30, 1865, both from the Hambleton shipyard just upriver from Litherbury's establishment.[49] By this time, monitor launchings had become "old hat" in the Queen City. The *Catawba,* the first Cincinnati monitor to be launched, had merited front-page coverage in the *Cincinnati Daily Commercial.* A month later, the *Oneota*'s launching was the subject of an article only a fifth as long, on page 2, and the *Tippecanoe* in her turn received only a paragraph. The *Yuma,* the last of the five Cincinnati ships to be launched, had to make do with a single sentence, buried next to a report that the towboat *Allegheny Belle No. 4* had been sent to pick up a load of corn.[50] In Pittsburgh, Snowdon & Mason launched the last western monitor, the *Umpqua,* on December 21, 1865, six months after the end of the war.

By October 1865, of the nine harbor and river monitors, only the *Tippecanoe* remained in the builders' hands. When that ship arrived in New Albany in late March 1865, the local inspector estimated that it would

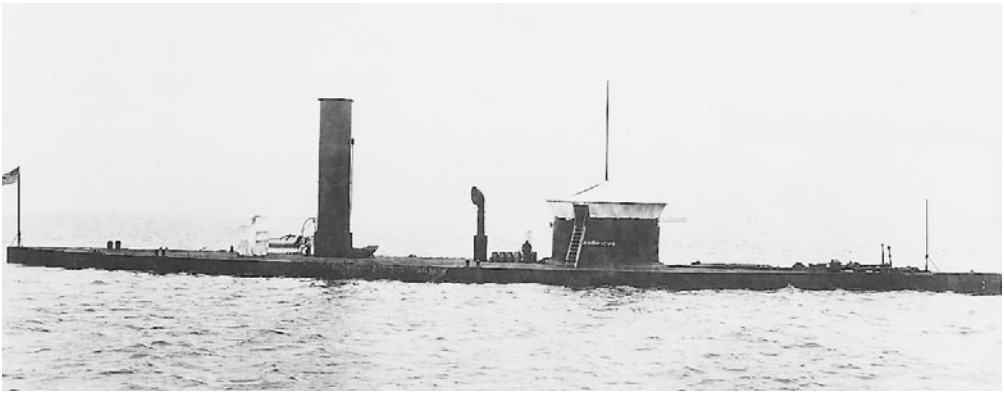


Fig. 8.2. The Tippecanoe-class monitor *Canonicus* about 1907, little changed from her original appearance. Naval Historical Center photograph NH-55202.

take six months to complete her. In late May, Greenwood moved the ship to deeper water at Evansville, Indiana, to complete the hull, and the inspector's forecast then was five more months. Evansville suffered from an unhealthy climate and rudimentary facilities. At times during the summer, half the mechanics were sick with chills and fever, while getting the guns mounted on their carriages with no mechanical assistance except hydraulic jacks took nearly the whole available workforce. In the autumn, the engines were completed, but they could not be tested because the low water in the river kept the ship from being moored securely enough to take the strain.[51] The ship finally steamed to Cairo, Illinois, for inspection in January 1866.

February 8, 1866, was the date appointed for the *Tippecanoe*'s acceptance inspection. A naval board headed by Commodore James F. Schenck reported that "no pains have been spared by the Contractors to make her perfect," and the Navy officially accepted her on February 20, 1866.[52] Miles Greenwood must have heaved a huge sigh of relief. The contract that he had so confidently expected to complete in March 1863 had stretched nearly three years longer. The *Tippecanoe*'s acceptance marked the completion of the harbor and river monitor program.

CHAPTER 9

Good for Fifty Years

Winding Down the Mobilization

It has been said that the armed forces of democracies hit their stride just about the time the war ends. This was certainly the case with the Civil War Navy's ship acquisition programs. By late 1864, Fox had been weaned from the continuous improvement philosophy and the negotiation method of making changes had begun to gain momentum. The excesses of the monitor project office had been curbed, and corrective action was being taken on the worst excess, the light-draft monitors. The acquisition bureaucracy had realized that withholding money from financially strained contractors was counterproductive, and Gregory's efforts to clear up the backlog of claims were bearing fruit. The expansion shipyards of the West were building quality ships as fast as the available labor supply would allow. The war had been a harsh teacher, but the Navy appeared to have learned its lessons—management and contracting had been brought into line with the technical aspects of the program.

By the time the "New Navy" of the 1880s began to appear, however, few traces remained of the massive industrial mobilization of the war years, and the lessons of the war had been largely forgotten. Contracting had regressed to the practices of the 1850s. The wartime shipyards of Pittsburgh and Cincinnati had vanished, and most East Coast yards had followed. The project office form of organization had evaporated. One study contended that after the Civil War, the Navy returned to its prewar routine so completely that a visitor "returning in 1870 after ten years' absence might never have guessed that the Navy had passed through any war at all."[1] Later authors have shown there was much concealed under the Navy's relatively placid surface, but the assertion of changelessness is not far off the mark in the area of shipbuilding.

Dismantling the wartime acquisition system began even before the dissolution of the Confederacy. In February 1865, Welles directed his squadron commanders to reduce expenses, and the general superintendent's office joined in the reductions. The second Port Royal Working Party had returned north without replacement in May 1864. In November 1864, Welles consolidated Captain Joseph Hull's western supervisory organization with Gregory's office, and in May 1865 General Inspector Wood directed Chief Engineer Loring to reduce the number of inspectors in the West and to discharge all of them as soon as possible.[2] Yet the monitor contractors continued to build and the Navy continued to pay for ships that could not possibly be finished in time to fight. In view of Welles's very strong push for economy, the modern observer is tempted to ask why the Navy did not cancel the uncompleted ships.

In hindsight, there would have been much to recommend that course. By the end of 1864, the naval situation had turned strongly in favor of the Union. Mobile, Alabama, had fallen. The Confederates had destroyed their ironclads at Savannah, Georgia, to prevent their capture. Charleston was tightly blockaded and threatened by the Union Army. Cushing's raid had eliminated the *Albemarle*, and Wilmington, North Carolina, the Confederacy's last seaport, was under attack. The likelihood of European intervention, declining since 1863, was negligible. The North had reelected Lincoln, and the Confederacy was tottering. In later mobilizations, the perception of the war being on the downhill slope would lead to massive cancellations, not only of ships contracted for and not commenced, but also of ships actually under construction.[3]

Several factors militated against cancellation, however. The Union had seen many reversals of fortune, and the picture of "war on the downhill" is far clearer in retrospect than it was to contemporary leaders. Similarly, while European powers would not intervene to support a failing rebellion, the Union had differences of its own with them, especially with Britain, and it was not at all clear in 1864 that those differences would be settled amicably. Fox had spoken for many when he wrote, "We are fighting Great Britain on the high seas. She is at war with us but we are at peace with her, and there is no defence except retaliation."[4]

A second factor was that the monitor contracts contained no cancellation clause. If the government canceled the contracts, it would still have to pay the contractors the full value of the contracts and would still have

to resolve the contractors' outstanding claims, but it would have no ships to show for the expense. Such a policy would have been attacked immediately as evidence of corruption, of culpable waste, or of a gross lack of common sense. In the case of the light-drafts especially, it would have been taken as an admission that the ships were total failures.

The most important reason to finish the ships, though, was the widespread perception that they would be useful in the long term. Inspecting the *Catawba*, *Oneota*, and *Tippecanoe* in April 1865, Chief Engineer James W. King commented favorably on their construction and observed, "If they be placed in careful hands and kept properly preserved, they will endure half a century, and in the event of a foreign war will doubtless become of great value to the nation." John Ericsson wrote that if updated and properly cared for, "vessels like the monitors are good for *fifty* years." America did not or would not recognize that technological change demanded constant military modernization. Congress and voters persisted in "the false but soothing perception that military goods once appropriated were durable and good for generations."[5] In the absence of any savings, there was no incentive to cancel the ships, and there were many reasons to finish them.

Making the Navy's expanded industrial base permanent was likewise at issue. The Navy's industrial mobilization, or at least the western part of it, began as an experiment and turned into an investment. Driven by the intense urgency of 1862, the Navy risked expanding beyond the eastern seaboard to meet its needs for ironclads. By 1863, it was clear that building monitors was more difficult than at first supposed. "Experience has shown that all the contractors for the Iron Clads were equally mistaken in their calculations of time, and took double or more to complete them," Gregory reported.[6]

Enough data had accumulated, however, to show the potential for building ships west of the Alleghenies, which not only took advantage of the "natural facilities . . . of that part of the country," but gave the Navy a secure base "if our sea coast should ever become seriously harassed by any great Naval power." Most agreed that western builders could compete with easterners on quality and needed only encouragement to be able to build as rapidly and as cheaply. Patience would be required to make the investment in western builders pay off, and the tacit waiver of

the six months' limit in the Tippecanoe-class contracts was aimed at building up western industry.[7]

Rear Admiral David D. Porter, who visited Cincinnati in February 1864, made a similar observation, although he was more optimistic than circumstances warranted about rapidity of construction. If the Navy planned to build more monitors, Porter recommended "that a fair portion of patronage be given to the Western foundries." The West, Porter wrote, should be "converted into a large workshop for the building of future monitors of all sizes. I know of no part of the Union where the work can be done quicker or better."[8]

Despite this endorsement, the western shipyards withered almost as fast as they had grown. A few months after Porter visited Cincinnati, Congress directed the Navy Department to appoint a commission to select a site for a Navy yard on the Mississippi or one of its tributaries. Rear Admiral Charles H. Davis headed the commission, which reported in February 1865. Because of their industrial facilities, the commission considered Carondelet, Cincinnati, and Pittsburgh as candidate locations for a construction yard. Hydrography made a critical difference among these sites.[9]

Porter had inveighed against "the senseless cry about the want of water, here or there," for at low water, no place had an advantage.[10] The Davis Commission looked more closely, however, and found that low water made more difference in some places than in others. Pittsburgh was the worst, as a vessel drawing eight to ten feet could pass down from Pittsburgh to Cairo during only four months of the year, and that time might be further reduced by the river being frozen. Navigation from Cincinnati was somewhat easier, and from Carondelet about the same as from Cincinnati, but statistics confirmed what had been especially painful for Greenwood and Snowdon & Mason: low water was common and during periods of low water, heavy ships could not move. Major delays were thus almost guaranteed.

Hydrographic considerations drove the Davis commission's recommendation to establish one building yard at Carondelet and a second at Cincinnati, but to locate a naval station at Mound City, from which ships drawing ten feet could reach the ocean nine months out of the year.[11] Combined with the greater cost of western-built vessels, draft re-

strictions and transit delays made construction on the western waters very unattractive in peacetime.

In the East, the situation was different. Physically, the availability of raw materials formed the major reason for the decline of New York and Boston as shipbuilding centers in the late 1860s and 1870s: easy access to raw materials gave Delaware River shipyards a competitive advantage and allowed them to eclipse the older yards. Like the Delaware yards, the western yards had easy access to iron and coal, but the eastern shipyards were located on salt water, or on tidal rivers that never ran dry. An eastern shipyard might suffer from cramped quarters, but hydrographic obstacles were negligible compared to western conditions. The uncertain hydrography of the Mississippi River and its tributaries was perhaps the most important factor that kept the Civil War industrial expansion in the West from becoming permanent.

Administratively, the project office form of management was the major innovation of the war. It had many advantages, and Stimers's proposal to institutionalize it by creating a Bureau of Iron Clad Steamers would have been a step forward for the Navy. The delays and expenses of western shipbuilding played their part in the reaction against the project office form of acquisition management, but it was the light-draft fiasco that completely discredited it. The general superintendent's office closed on November 1, 1866, and its records were sent to the Bureau of Construction and Repair in May 1867.[12] The long-running and occasionally bitter feud between line officers and engineers combined with postwar revelations of contracting scandals and cost overruns to ensure that the proposal for a new ironclad bureau would not be revived.

While the line-engineer dispute is beyond the scope of this work, some background is in order. Centuries before, there were two kinds of officers aboard ship—the fighters, who were in charge, and the seamen, who merely moved the ship. Over time, it became tactically important that the fighters also know how to operate their ships. Landsmen fighting officers found this beneath their dignity, so seamen gradually became seafighters—line officers—and displaced the landsmen. Steam propulsion brought a similar split between the men who made the ships move and the men who directed and fought them, and like the landsmen fighters, the line officers considered the new motive power to be beneath their dignity. A separate class of officers appeared—the Engineer Corps. The

Civil War's emphasis upon steam propulsion increased the standing of the engineers, and in March 1863, Welles recognized their growing importance by administratively raising engineers' ranks relative to those of line officers.

The line reacted strongly to the engineers' agitation, and feeling among line officers ran high where engineers were involved. In one case, a commanding officer ordered his engineer to act in a way that the engineer thought would endanger the ship's machinery. The engineer refused to obey, asserting that the captain had no right to give orders to the engineers. The engineer received a light sentence at court-martial and Admiral Samuel Du Pont, his squadron commander, was enraged. Any engineer who made a similar assertion, Du Pont wrote, would go north in double irons.[13]

In their total dependence upon steam power, monitors were truly engineers' ships. Ericsson's characterization of Percival Drayton, the captain of the *Passaic,* as "only a seaman" echoed the attitude of many engineers: the monitors were war *machines.* Men who employed machines should know how they worked, or at least listen to advice from those who did know. Ericsson, reporting a divergence of opinion between a "skillful practical engineer" and his commanding officer, observed, "It has often given me pain to think that our fighting *machines* are entrusted to officers who know nothing of mechanics and *therefore* have no confidence in their vessels." On at least one occasion, Stimers recommended to Fox that a specific officer be sent to command a monitor because that officer had "a great admiration for mechanism." Even more extreme was Chief Engineer Wood's application for command of a monitor. This was too much even for Stimers, who recommended that Fox "let it pass in silence," because "every naval officer ought know" that such a change was not admissible.[14]

The monitors thus became a focus for discontent on both sides of the line-engineer divide. For one thing, the ships were perceived as being more complex than earlier vessels. (This clearly derived from their novelty—to a modern naval officer, it seems incongruous that men who were intimately familiar with the dozens of braces, stays, halyards, sheets, tacks, clews, clew-jiggers, clew-garnets, buntlines, bowlines, downhauls, outhauls, leech-lines, brails, and bunt-jiggers needed to operate a square-rigged vessel should have complained about complexity!)

For another, the monitors' guns were mounted in steam-driven turrets, so they depended upon mechanism (and thus upon engineers) for their entire fighting power. Line officers had grudgingly accepted the intrusion of steam propulsion, in part because they could leave the engineers literally to their own devices belowdecks. Depending upon engineers for the ability to fight was a new and disturbing encroachment on the line officers' territory. They reacted by reasserting their control over what Drayton called mere engineers and mechanics.[15]

The prospect that the chief of the Bureau of Iron Clad Steamers would be an engineer would have alone been enough to arouse opposition among line officers. The real failure to establish such a bureau, however, can be traced to the failure of the continuous improvement method of building ships. Fox's aversion to alterations came over a year too late, and his epiphany in favor of ships "upon which not a single alteration, addition or improvement had been added" highlighted the single most important lesson to be learned from the industrial mobilization effort: better is the enemy of good enough. Major changes during construction caused major delays in the monitor program, which combined with a simple but monumentally expensive technical failure to discredit the organization responsible.

By war's end the Navy had also begun to learn some lessons in contracting. Had it been implemented as was intended, the negotiation clause of the light-draft contract held great promise for reducing delays and cost overruns. Similarly, the Navy appeared to be moving toward more sophisticated appreciations of contractors' costs and of the effects of delay and disruption upon contractors' work.

Yet the end of the war brought revelations about scandals and excessive profits, and the postwar reaction reversed the trend toward flexibility in government contracting. Urgency could no longer provide an excuse to waive the more onerous requirements, and the scandals seemed to give good reason to make the requirements even more onerous. The result was a renewed exaltation of competitive bidding and a multiplication of rules to prevent fraud.[16]

The failure of many contractors to deliver on time and within budget gave ammunition to those who sought to gain political advantage by at-

tacking the Navy. In a defensive reaction, Welles tightened up contract administration. "As the contract with the Government stipulated the price, neither I nor the Administration could vary the contract," he opined in one case. "The law and the contract must govern me," he wrote later. "Equity power is with Congress."[17] The change in tone from his wartime willingness to bend the rules is noticeable. For the Navy, the postwar period saw contracting swinging back toward an 1850s model.

The contracts made during the war, however, had long-term consequences, and it took far longer to wind down the Navy's mobilization than it had taken to start it. Many contractors had been financially hurt, and their cries of pain were heard both during the war and after it. Having discussed the causes and short-term effects of delays and inflation, let us now examine the longer-term consequences.

The first Navy effort to compensate ironclad contractors was the Gregory Board, chaired by Admiral Francis Hoyt Gregory, which met irregularly from its creation in October 1863 until May 1867, heard the arguments contractors presented to it, and settled their accounts.[18] After Gregory's sudden death in October 1866, his principal subordinate, Commodore Cadwalader Ringgold, assumed the position of general superintendent and with it the presidency of the board until his own sudden death in April 1867. Welles intended the Gregory Board to deal only with increased costs resulting from the changes ordered by the Navy, so the board considered only the direct costs of the "extras," without incorporating delay or inflation, and without considering the effects of delay and inflation on the original contract work. For the contractors, the Gregory Board payments were better than nothing, but they would not accept them as the final settlement of their claims. As Welles later testified, the contractors "obtained all the allowance they could get from the Department, and then they appealed to Congress."[19]

The Navy assumed that its acquisition system would permit contractors to make a profit, but by 1864, almost all of them were losing money. A representative editorial, from the *New York Times* of February 14, 1865, discussed the problem of reimbursement in cases, "in which *the action of the Government itself* has substantially changed the conditions under which contracts were made, and thus rendered their fulfillment diffi-

cult." Blaming the government for inflation and the draft, the newspaper wrote that contracts made three years before now imposed "enormous burdens" on the contractors. Relief, said the *Times,* was required.[20]

In March 1865, the Senate acknowledged the clamor by inquiring into the losses that vessel and machinery contractors had sustained. Under this authority, in May 1865, Welles appointed Commodore Thomas O. Selfridge as president of a board to investigate. The Selfridge Board received claims directly from the contractors and ascertained the amounts by which their costs exceeded the Navy's payments. Following its congressional charter, it did not try to determine which excess costs were the responsibility of the contractors and which were chargeable to the government. Its report thus did not provide enough information for Congress to be comfortable about paying any claims; for contractors, the Selfridge Board report was at best a moral victory.[21]

In March 1867, Congress tried again, directing the secretary of the Navy to investigate all claims from contractors for vessels and machinery, ascertain the increased cost over the contract price, and determine how much of it was the government's fault. The resulting board, headed by Commodore John B. Marchand, reported to Congress via Welles in December 1867. The Marchand Board's "determinations" were generally lower than the amounts allowed by the Selfridge Board. This was partly because the Marchand Board refused to allow anything for inflation if it felt the contractor could have avoided increased costs by "ordinary prudence and diligence."[22] In July 1868 Congress directed payment of several Marchand Board claims, including those for the five eastern-built Tippecanoe-class ships (Loring's *Canonicus,* Harlan & Hollingsworth's *Saugus,* and the Secors' *Manhattan, Tecumseh,* and *Mahopac*), with the provision that such payments should be "in full discharge of all claims against the United States."

After accepting the payments and signing the full discharge receipts required by the law, the contractors immediately returned to the fray, asserting that the amounts allowed were still too low and that they had been forced by "overpowering necessity" to accept what the Navy offered. The Secors, for example, later complained that the government "kept us so poor we signed anything."[23] Accordingly, the new secretary of the Navy, George M. Robeson, ordered yet another board, under Commodore Charles S. Boggs. The Boggs Board reviewed the claims of three

contractors in 1869, and in 1870, Robeson paid Secor & Co. another $93,000 for the *Manhattan, Tecumseh,* and *Mahopac* based on its recommendation.[24]

The Navy intended that the boards would resolve all of the outstanding claims, and the government paid some contractors based on their findings. The multiple boards tended to overlap, however, making it difficult to trace either a specific contractor's claim or the Navy's thought processes in dealing with that claim. The picture becomes more confused because the boards were not the only venue in which contractors could seek redress. Those who were unsatisfied, either with the amount they recovered or with the recovery process itself, could bypass the executive branch and pursue their claims in Congress or in the courts.

Congress could act on behalf of contractors either indirectly or directly. Indirectly, Congress could order an executive agency to investigate a claim or a class of claims (as with the Marchand Board), then approve or amend the agency's findings and appropriate money to pay the claimants as required. Also indirectly, Congress could change existing laws (such as statutes of limitations) to permit contractors to sue for relief in the Court of Claims. Directly, Congress could pass a private bill appropriating money to settle specific claims; while this might seem to be the simplest approach for a contractor, a private bill took a good deal of expensive lobbying, and passage was far from a foregone conclusion. Ironclad contractors approached Congress to act in all three ways.

Besides the ever-present issue of properly using influence to respond to one's constituents, Congress had to resolve a tug-of-war between two principles. On one hand, the contractors had lost money as a result of governmental actions, both direct and indirect: the delays induced by direct government action exposed the contractors to the indirect inflationary effects of the government's fiscal policies. Equity demanded that the contractors be compensated. "The fact that these parties went on and fulfilled their contracts after it became apparent that to do so would involve them in loss," thereby completing vessels that were "indispensable in prosecuting the war to a successful termination," was "certainly laudable."[25] Now that the country was "out of danger and can afford to do simple justice to those citizens who worked for it faithfully in its hour of need I have no hesitation in saying that I regard [Secor & Co.'s] claim as a just one and should be paid," Stimers wrote Robeson. In his view, the

contractors were "upright and meritorious men, who are not seeking to prey upon the government, but to obtain a just compensation for losses they have suffered by the government's own act."[26]

On the other hand, it was argued, the contractors had entered into contracts upon which they had expected to make a profit but that carried a normal level of business risk. The government should compensate contractors for increased costs due to direct government action (such as changes and drawing delays), but it was not obligated to go further and guarantee a contractor a profit, especially if the contractor had managed his business poorly. "It comes exactly to this: . . . [the contractor] has made a bad bargain, or rather a hard bargain with the United States, by which he is not likely to make money," Senator Jacob M. Howard of Michigan declared. "Congress should be just, but it has no right to surrender the rights of the United States . . . and tax the whole public" to pay such claims, another legislator said. Some were less charitable. "There have been the grossest abuses practiced in this business of iron-clad vessels," Congressman Elihu B. Washburne of Illinois asserted.[27] In many minds, the ironclad contractors were lumped together with profiteers and frauds.

The debate continued for some time without resolution. "It was the heaviest lobby, I think, I ever knew before Congress and before the Department," Welles observed in 1872.[28] Meanwhile, besides pursuing their claims through Congress, contractors sought to recoup their losses by selling ironclads to foreign governments. In this respect, 1867 and 1868 were banner years, as the casemated seagoing ironclad *Dunderberg* and the twin-turreted monitor *Onondaga* were sold to France and the *Catawba* and *Oneota* to Peru. Superficially similar, the sales differed in important details.

The *Dunderberg,* built by New York's William H. Webb, became the subject of a private bill introduced in February 1867 and passed in the hectic last hours of the Thirty-ninth Congress in March. The result of a year's lobbying by Webb and his political friends, the bill authorized Webb to buy the never-delivered *Dunderberg* by refunding to the government the money he had received as progress payments.[29] The shipbuilder George Quintard benefited from a bill that allowed him to repurchase the *Onondaga* in the same way, although *Onondaga* had been delivered to the Navy and had served as a commissioned ship. The

French government bought both ships, giving their builders a tidy profit.

In October 1867, Gustavus Ricker, acting as agent for Swift & Co., negotiated a deal to sell the *Catawba* and *Oneota* to the Peruvian Navy for a million dollars each. Since Swift had delivered the ships to the U.S. Navy, the deal assumed that Swift would be able to repurchase the ships as Webb and Quintard had repurchased theirs. Initial contacts with the Navy Department indicated that this would be allowed, but Welles then decided that the laws passed in March 1867 applied only to Quintard and Webb. Soon afterward, on December 12, 1867, the House debated a resolution authorizing the secretary to relinquish ironclads to their builders on the same terms granted to Webb and Quintard—that is, to refund of the price paid by the government. After the House amended the resolution to require sale at a price fixed by a board of officers, it went to the Senate.[30]

The Senate in its turn amended the House resolution to forbid the sale of certain classes of ironclads: the Dictator, Kalamazoo, and Monadnock (or Miantonomoh) classes (the newest, largest, and most capable) and the Passaic class (the oldest and most battle-worn). It also required competitive bidding, mandating acceptance of the highest price offered as long as it was above the appraised value. The House concurred with the amendments and President Andrew Johnson approved the resolution on February 3, 1868.[31]

Welles promptly convened a board, which appraised the *Catawba* at $380,000 and the *Oneota* at $375,000, less than two-thirds what the Navy had paid for them. After some machinations in which Swift & Co., or at least Ricker, may have colluded with other bidders, the two ships were sold to Swift on April 11, 1868, for the appraised total of $755,000. At the instigation of Congressman Washburne, the Joint Select Committee on Retrenchment investigated the allegedly fraudulent sale.[32] The committee's fulminations could not obscure the fact that Swift & Co. had been prepared to repurchase the two vessels for what the Navy had paid for them—that is, about $1,250,000. Congressional obsession with competition, reflected in the provisions mandating appraisal and competitive bidding, cost the government half a million dollars. Although some congressmen, subscribers to the idea that the monitors would be "good for *fifty* years," tried to block the sale, Welles was more realistic: "Simpletons, I wish we could sell all," he wrote in his diary.[33]

By 1868, when Swift & Co. took possession of the *Catawba* and *Oneota,* experience had made the unsuitability of the Mississippi River system for naval facilities even clearer than it was when the Davis Commission reported in 1865. As each was completed, the western-built Tippecanoes were berthed near Mound City, along with several light-draft monitors (Fig. 9.1). In mid 1865, the *Catawba* and *Oneota* were moved to deeper water opposite Cairo, with caretaker crews to protect them from thieves and accidents.[34] As winter neared, the *Manayunk* joined them; because of their draft, all three had to be anchored in the main channel, where they were exposed to ice, drifting trees, and accidents.

In February 1866, the *Tippecanoe* joined her sisters, just in time to demonstrate the hazards of the anchorage. On March 27, 1866, a steamer towing barges parted the *Tippecanoe*'s anchor chain, she drifted into the *Oneota,* and the vessels were carried two miles down river before they were finally brought under control. After four collisions, the *Tippecanoe* had lost both anchors and the *Manayunk* and *Oneota* one apiece. The deep-water anchorage they needed was unsafe for the ships themselves and for other river traffic. The incident precipitated the Navy Department's decision to move the vessels downriver to New Orleans, a move hastened by the river being high enough to let them pass.[35]

The monitors made the voyage under their own steam because towboats powerful enough to tow them were scarce and expensive. Lieutenant Commander Elias K. Owen assembled scratch crews, and the four harbor and river monitors left Cairo at noon on May 14, 1866. After delivering the vessels to the Naval Station at New Orleans, Owen and his men returned to Mound City on June 2, 1866.[36] In August 1867, the *Catawba* and *Oneota* were turned over to Swift & Co., which refitted them in New Orleans for the Peruvian Navy.[37] Once the requirements of neutrality were met (Peru had been at war with Spain, and a neutral's sale of warships to a belligerent was at the heart of the Union's "*Alabama* claims" against Britain), the two monitors, renamed the *Atahualpa* and the *Manco Capac,* spent sixteen months making their way around Cape Horn to Callao, Peru. They arrived in May 1870.[38]

With the exception of this repurchase episode, the western firms abandoned shipbuilding almost completely when they delivered their monitors to the Navy. Some authors claim that the industrial progress generated by the Civil War was illusory, and this is certainly the case with the

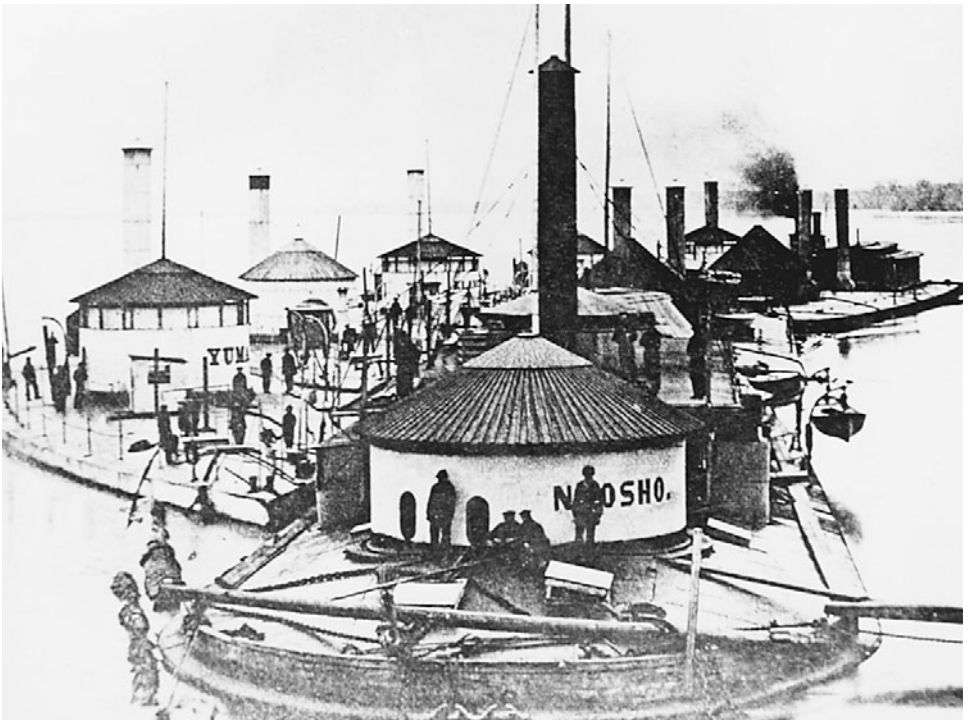


Fig. 9.1. Monitors at Cairo, Illinois, after the Civil War. The Cincinnati-built *Yuma* is at the left; her sister *Klamath* is third from left. From the collection of the Public Library of Cincinnati and Hamilton County, Inland Rivers Collection, pl. 9365.

"expansion" shipbuilders, Swift/Niles, Greenwood, and Snowdon & Mason. They could not continue to build ironclads, since there would be none to build; the postwar Navy was chockablock with monitors, which eliminated support in Congress for further ironclad construction. Neither could the firms build commercial ships; laying aside the uncertainties of the Ohio River, their high costs priced them out of what commercial market there was.[39] The decade of the 1860s ended as it began in Cincinnati and Pittsburgh, with a few small facilities repairing ships and none building them. Even in the shipbuilding boomlet of 1871–76, only two Cincinnati-built metal vessels were registered; Swift & Co. built the 329-gross-ton *Alex. Swift* in 1873 and Litherbury built the 720-gross-ton *John T. Moore* in 1871.[40]

The better-established eastern firms did not prosper, either. American shipbuilding suffered a severe depression after the war, as surplus ex-Navy ships glutted the commercial market. Few firms could make a profit, let alone compete with British industry in building new iron vessels.[41] Yet depressed demand was not in itself the cause of the demise of so many American shipyards; there had been shipbuilding depressions before. The secondary effects of the monitor program compounded this depression.

The monitor program has been touted by proponents then and now as giving great impetus to iron shipbuilding in the United States. Technologically, one can make a good argument for this: the wartime program established in short order a body of standard solutions and shop practices that would have taken far longer to develop in peacetime, as well as training thousands of workers to build ships of iron. Economically, however, just the opposite is true: participation in the monitor program grievously harmed many shipbuilders by depriving them of the resources that might have helped them weather the postwar depression. When shipbuilding briefly turned upward again during 1871–76, most of the monitor builders had already folded or left the business.

The Cramp shipyard (William Cramp & Sons) is often put forward as an example of a wooden yard that used the experience of ironclad construction to make the transition to iron shipbuilding.[42] Yet Cramp actually had little ironclad experience. In 1861–62, Cramp designed the *New Ironsides,* built her wooden hull, and installed her armor as a subcontractor for Merrick & Sons. In terms of construction problems, however, the *New Ironsides* barely qualified as an ironclad; she relied heavily on traditional shipbuilding techniques, and Cramp learned nothing about building hulls in iron. After completing the *New Ironsides* in August 1862, Cramp built no more ironclads until March 1863. Charles Cramp did not mince words about the reason: "We were not in what was called the 'Monitor Ring.'" Cramp & Sons, he asserted, had been "ruled out of naval construction for a time."[43]

After the *New Ironsides,* Cramp's only other 1860s venture into ironclad construction came when the firm built the hull and turret for the light-draft monitor *Yazoo,* also under a Merrick subcontract. Other firms did far more ironclad work; some built five or six monitors and others built at least three. Despite a minuscule trade in ironclads, Cramp's yard was

far from idle. Besides its commercial work, it received at least eight contracts from the government, and between 1862 and 1865, it built at least ten passenger steamers, four transports, a double-ender gunboat, and a cruiser. The Cramps profited largely, doubling their capital from $100,000 to $200,000 between 1863 and 1865, increasing it to $250,000 in 1868, and doubling it again to $500,000 by the time they incorporated in 1873.[44] The Ericsson group's determination to "suppress" the *New Ironsides* type and its builders may have been the best thing that could have happened to Cramp's firm.

Several factors affected a monitor contractor's chances of surviving and making the transition to iron shipbuilding. First, the firms most heavily involved in the post-Passaic monitor classes were the most likely to fail or to give up shipbuilding for other work. Second, firms that had begun as ironworks or machinery builders seem to have been more likely to survive than the few who began as shipbuilders. Third, firms that gained their initial expertise in iron shipbuilding before the war or early in the conflict were more likely to survive than those who started later.

The Secors exemplify late concentration on monitor building. When the harbor and river monitors were offered in August 1862, the Secors were building the Passaic-class *Weehawken* and making excellent progress. They were also building the *Camanche*, which was going much more slowly, but her design and circumstances made her unique. When the Navy advertised for the harbor and river monitors, the Secors were optimistic, and Ericsson boosted their hopes when he suggested to Charles Secor that they could make $20,000 per ship.[45] If anyone could estimate the cost of a monitor credibly, it would be Ericsson, the Secors thought, and with his assessment in hand, they took on three of the Tippecanoe class.

The Secors had clearly learned much from the *Weehawken* and *Camanche,* but their experience and "energies" could not compensate for specification growth. The specifications called for far more ship than did the contracts. Combined with the changes applied later, they more than took away the potential profit and started the Secors down the path toward fifty years of claims and litigation. After the war, the Secor firms, drained of capital, gave up shipbuilding. James Secor was asked in 1872 if he were engaged in government work. He testified, "No, sir; and never intend to be."[46]

The inflation and design changes that plagued the Tippecanoe and Casco classes increased the cost of building the ships far beyond the price the government had agreed to pay, and the contractors had to pour more and more of their own capital into them. The Secors had contracted to build the *Tecumseh, Manhattan,* and *Mahopac* at $460,000 each. After being paid for changes and alterations, by 1867 they had received about $630,000 for ships they asserted had actually cost $872,000 apiece to build.[47] Other builders had the same experience. Swift & Co. received over $161,000 extra for each of its Tippecanoes, but claimed $114,000 per ship on top of that. Greenwood received $173,300 over the contract price for the *Tippecanoe,* then sued for $176,000 more. McKay and Aldus contracted for two light-drafts for a total of $781,000; they received extra payments totaling $605,800 and still claimed $49,000 more.

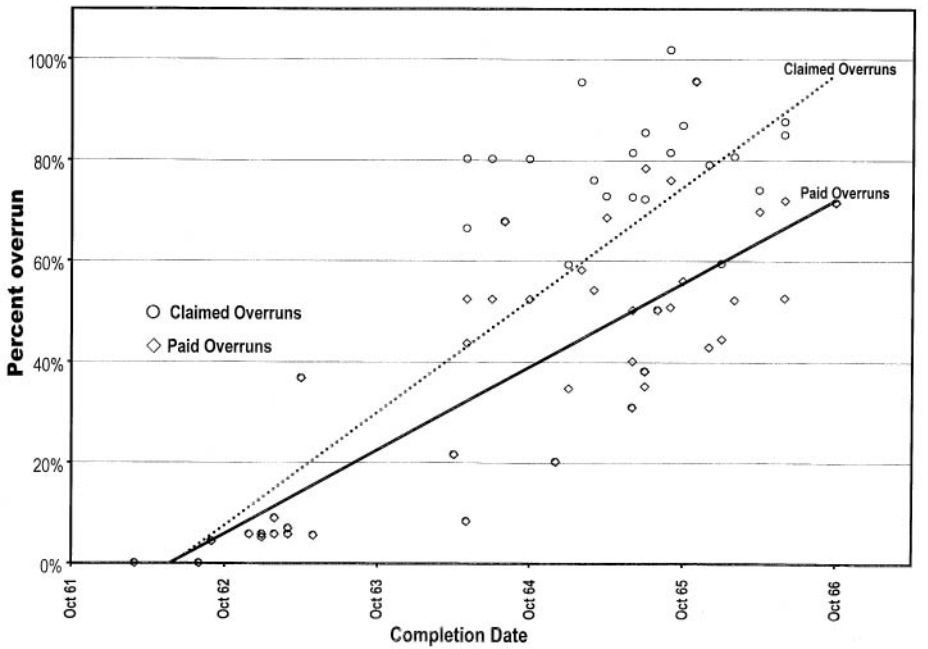


Fig. 9.2. Paid and claimed cost overruns as a function of completion date for contract-built ironclads, 1862–67. Various sources.

Although most monitor contractors did eventually receive additional compensation, it was often too little and too late. Many firms were hit with the one-two punch of capital starvation and shipbuilding depression. They did not have the resources to get back into shipbuilding by converting their yards to iron construction. Like the standardization overemphasized by the monitor bureau, the seemingly attractive contracts of 1862 bore poisoned fruit.

Most of the monitor builders, including Swift/Niles, Snowdon & Son, Continental, Atlantic, City Point, and Delamater, had begun as ironworks or machine shops rather than as shipbuilders. Most such firms survived by withdrawing from shipbuilding to resume their core businesses. On the Ohio, the Swift/Niles group dissolved, with Swift returning to making iron and Niles to machine shop production.[48] In 1867, Swift sold out to an incorporated company called Swift's Iron & Steel Works, which claimed paid-up capital of $400,000. Alexander Swift's 1867 credit report shows that he survived his venture into wartime contracting without serious difficulty.[49] By luck, good management, and aggressive marketing of surplus ironclads, Swift had done well.

Niles Works, harder hit by the monitor program, did not do as well. In 1860, the firm's capital was $258,600. Despite having spent the war with "heavy business," "more than they can do," its worth in 1866 was estimated at only $100,000. "The principal trouble with this concern is the want of available means," the credit-rating firm R. G. Dun & Co. noted in 1869. Details are lacking, but it appears that Swift ensured that the Swift/Niles shipbuilding group kept current during the war on its bills for material from Swift's ironworks, which protected Swift and his ironworks but drained capital from Niles. In 1870, James W. Goff, George A. Gray Jr., and Alex Gordon took over the Niles Works, which began again to prosper under this new management.[50] Although involved with Swift in claims to recover its losses on the *Catawba* and the *Oneota*, Niles did not participate in the Peruvian sale.[51]

In Pittsburgh, Snowdon & Mason "dissolved & left the city" in May 1867, a year after completing the light-draft monitor *Umpqua*. Even before the firm completed the monitor contract, however, Mason's death had reduced the partnership to Snowdon & Son. The sheriff sold Snowdon & Mason's assets to satisfy the firm's debts, and Snowdon & Son went

back to their ironworks and machine shop businesses. In 1867, the elder Snowdon retired, leaving one son the rolling mill and the other son the machine shop. Both were reported as being "in g[oo]d cr[edit] for bus[iness] wants." By 1871, however, they were reported as having quit business and "gone up the spout," probably because much of their capital had gone into building monitors.[52] Their claims were not settled for over twenty years.

In the East, as well, engineering and ironworking firms returned to their roots. New York's Delamater was primarily an engineering firm. It had built one of Ericsson's "big pets," the *Dictator*, but retreated to ferryboats, water pumping engines, and refrigeration machines.[53] Continental, builder of six monitors, including the original, had also left shipbuilding; its proprietor, Thomas Rowland, stated in 1870 that he had "formerly [been] in the Ship Building bus[iness] during the war but [was] now only in the m[a]ch[iner]y bus[iness]." He reportedly had a $100,000 contract from a gas company, but later in 1870, the *New York Tribune* reported that Continental "is almost deserted and green grass is growing in nearly all of the shipyards which, five years ago, were alive with workmen."[54] The Secors, in second place among builders, with five monitors to their credit, had turned variously to railroad management, foundry work, and the ship chandlery that had been their prewar base. By 1869, William H. Webb, builder of the wooden-hulled, casemated ironclad *Dunderberg*, was the sole shipbuilder still in operation on Manhattan Island, and his yard sat idle from 1870 until it was sold in 1872.[55]

The *New York Times* complained in 1869 that, with the exception of gunboats being built for the Spanish government, "not a solitary marine engine or iron steamship is in course of construction in this great naval metropolis." It listed several well-known ironworks, noting that Allaire had become a stable; Fulton was selling its shops and tools; Aetna, after fifteen months' idleness, had taken up architectural ironworking; Neptune had become a sawmill; Morgan was "heroically laboring for a future that may never come"; and Quintard maintained a "precarious existence" through repairs and "an occasional job for Southern railroads."[56]

In Boston, things were similar, as the builders whose core competencies were machinery and ironwork returned to their roots. Loring's City Point Works had ventured into monitor building with the Passaic-class *Nahant*, followed by the Tippecanoe-class *Canonicus*. After the Civil War,

Loring for the most part dropped shipbuilding to concentrate on producing machinery for sugar and paper factories. In the early 1890s, City Point briefly returned to Navy work, building the "New Navy" protected cruiser *Marblehead* and three small tugboats.[57] Curtis's Atlantic Works built the Passaic-class *Nantucket* and followed it with a light-draft, but after the war, Curtis concentrated on a profitable business repairing steamships and building and repairing steam engines. The Atlantic Works also built tugs, ferryboats, and lighters.[58]

Meanwhile, Boston firms with traditional shipbuilding origins appear to have fared worse. Donald McKay had converted from wooden to iron shipbuilding to construct two light-drafts, but found no market for a reconversion. McKay and Aldus had turned to building locomotives after the war, but they too failed; Donald McKay's shipyard and McKay and Aldus sold their assets to the Atlantic Works in 1869.[59]

In the Philadelphia area, machinery firms again showed to advantage. Merrick & Sons returned to its very profitable machinery work when it finished the light-draft *Yazoo,* for which Cramp & Sons had built the hull. In 1871, the principals, Vaughn and William H. Merrick and John Cope, retired and sold the firm to Henry G. Morris. Morris reportedly paid $2 million for it (although this seems high) but quickly ran the business into the ground. The Merricks and Cope bought the works back for $291,000 in 1875. They soon resumed production of stationary engines and industrial machinery as the Southwark Foundry and Machine Company.[60]

As in Boston, resources made the difference for the Delaware River's shipbuilders. Reaney, Son & Archbold, with two pre-monitor iron ships to their credit, built two Passaics and a light-draft. The firm had been poorly capitalized when it was founded in 1860 and had overinvested in its facilities during the war; after the war, its funds were "all locked up" in improvements, "which causes them to be occasionally short." Eighteen ships over six years could not keep the firm afloat; it entered receivership in 1871 and was bought by John Roach in June of that year.[61]

Philadelphia's Neafie & Levy had also engaged in iron shipbuilding before the war. During the war, however, Neafie & Levy initially refused to deal with the Navy because of a dispute over payment for the *Pawnee*'s prewar engines; the firm felt that the Navy was not a reliable customer and had unrealistic expectations.[62] Although Neafie & Levy built engines

for the Navy, the monitor program did not drain its resources, because it did not participate in it.

Harlan & Hollingsworth, the most experienced prewar iron shipyard, survived and prospered in postwar shipbuilding. The company had two major advantages. One was better than average capitalization. The other was good timing: Harlan & Hollingsworth had learned to build ironclads while the firm could still afford the lessons. Exploiting its prewar experience in iron construction, the firm built one of the first monitors (the Passaic-class *Patapsco*). The knowledge thus gained early in the program helped it to complete the Tippecanoe-class *Saugus* (Fig. 9.2) in eighteen months, minimizing its exposure to the inflationary and labor pressures of 1864-65. The government paid only 8.4 percent more than the contracted price for the *Saugus,* changes and all, while the other Tippecanoe-class ships ranged from 35 to over 52 percent above the contract price. Harlan & Hollingsworth's overrun on the light-draft *Napa* was just over 31 percent; overruns on the other light-drafts ranged from 34.8 to 95.5 percent and averaged 59.3 percent. Entering the postwar period with more credit, less debt, and lower losses on its monitors than most shipbuilders, Harlan & Hollingsworth even so had to turn to building coastal steamers and railroad cars to survive.[63]

Cramp & Sons had not built iron ships before the war, although it had been associated with the experiments of Neafie & Levy's predecessor, Reaney, Neafie & Levy, in iron shipbuilding.[64] Partly by accident, Cramp took a middle course with regard to ironclads. Its subcontracted involvement with the *New Ironsides,* although it did not provide much in-depth knowledge of metalworking, allowed the firm to become involved in iron shipbuilding in a low-risk contract, followed by an enforced "time out" that let Charles Cramp think about the implications of his experience. When Cramp & Sons began its second ironclad, also subcontracted, the firm could more readily adopt the techniques and tools of iron shipbuilding.

In addition, when Cramp & Sons were "ruled out" of monitor construction during the critical year from spring 1862 to spring 1863, it had to build other types of ships. While its contemporaries eagerly built monitors, unwittingly sapping their corporate strength and their long-term prospects, Cramp's non-ironclad work made a profit and allowed the company to build up its resources. A major reason that Cramp & Sons

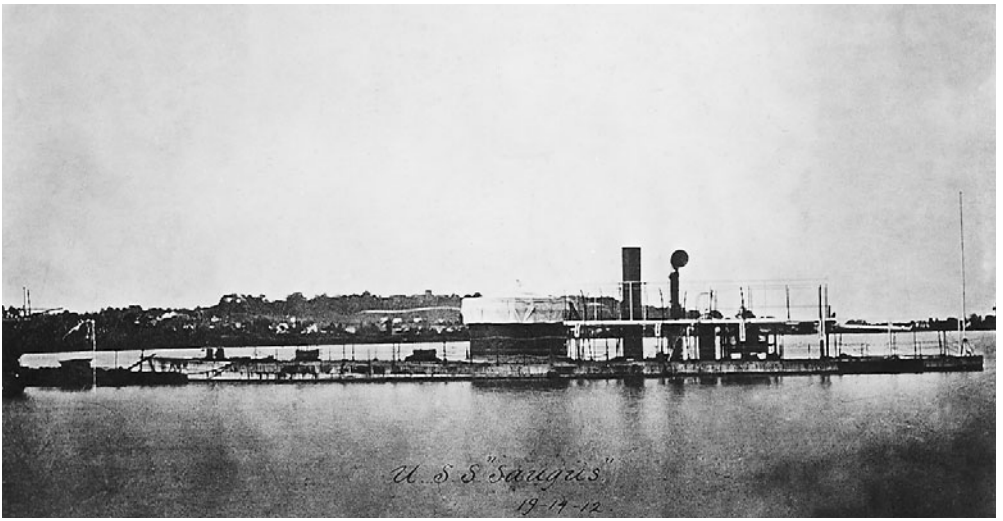


Fig. 9.3. The Tippecanoe-class monitor *Saugus* around 1907. Naval Historical Center photograph NH-97922.

could make the wood-to-iron transition after the war was that it had not built many ironclads during the war. This was the only firm to manage the double transition from wooden ships directly to ironclads and then to commercial iron vessels. By 1870, almost the entire iron shipbuilding industry of the country was located along the Delaware River, and Cramp & Sons had become an industry leader.[65]

Among yards west of the Alleghenies, one of the clearest examples of wartime experience retarding rather than promoting industrial development is that of Miles Greenwood. When the three western shipbuilders received their contracts in 1862, all three had to build shipyards and shipyard organizations. The three firms followed different paths to do so. The Swift/Niles consortium started from bare ground, building a shipyard from scratch. Snowdon & Mason also built its shipyard from the ground up, but one of the partners had shipyard experience with wooden vessels. By contrast, Greenwood rented an existing shipyard that had previously built wooden vessels, seemingly an advantage. Greenwood and Snowdon & Mason thus tried in different ways to gain an advantage by incorporating elements of existing technology.

The performance of the resulting establishments varied widely. The Swift/Niles consortium completed two harbor and river monitors in thirty-three months, built two light-draft monitors at a second shipyard at the same time, and produced material for the other western contractors as well.[66] Snowdon & Mason completed a harbor and river monitor in thirty-six months while building one light-draft. Greenwood required forty-one months to complete his single harbor and river monitor, even without the distraction of building light-drafts. While capital shortages affected the firms' relative progress, one may also conclude that the more a firm had invested in traditional wooden shipbuilding expertise, the worse its performance in ironclad shipbuilding was. Throughout the monitor program, as in iron shipbuilding in general, metalworking firms took the lead. "The iron ship was not a product of the wooden shipyard. It was a product of the machine shop."[67]

Such a seeming contradiction has been documented in other industries in which major technological discontinuities have occurred. A study of the transition from steam to diesel locomotive manufacturing shows that organizational strengths and core capabilities optimized for an old technology can be serious weaknesses when dealing with a new one. Similarly, shipyards found it extremely difficult to move from wood to iron; the technological discontinuity was so great that wooden shipbuilding and iron shipbuilding formed two distinct industries rather than branches of a single shipbuilding industry.[68] Like many with more or less experience of wooden ships, Greenwood and Snowdon & Mason "could easily imagine workers in their yards building an iron *ship* . . . but could they as easily have imagined their men building a *boiler?*"[69] Greenwood's and Snowdon & Mason's failure to recognize the discontinuity between "old tech" wooden shipbuilding and "new tech" iron meant their investments were probably counterproductive—all three western builders had lessons to learn, but Greenwood and Snowdon & Mason had to unlearn the old technology before learning to deal with the new. In general, the greater a firm's expertise in the old technology, the more difficulty it had in adapting to technological change.[70]

Another factor that affected Greenwood's performance relative to the other western firms was the degree to which each was truly a custom producer before the war. Niles Works and Snowdon & Son were both custom producers who specialized in complex items made to order. Without

detailed accounts, it is difficult to be sure, but it appears that Greenwood's prewar business was centered on batch or bulk production. Charles Cist's description of Greenwood's works in 1859 noted that the machine department turned out steam engines, mill machinery, hydraulic presses, and "hundreds of other articles," but it stressed goods such as stoves, hinges, architectural castings, and steam and gas fittings, most manufactured "in much greater quantities, than in any other establishment in the West."[71] Even Greenwood's 1861 venture into war production involved relatively simple items such as muskets and cannon rather than the true custom production characteristic of shipbuilding. Greenwood's inability to keep up with his competitors probably stemmed from a combination of capital shortages, ill-advised investment in outmoded technology, and a less-agile organizational mind-set.

By the end of the war, capital starvation and unreimbursed expenses had gutted Greenwood's firm. After the *Tippecanoe* was delivered in 1866, he limped along, obtaining a loan from friends for $100,000 in 1869. A decade later, R. G. Dun & Co. noted that he "has been for years engaged in fighting the Govt for money which he claimed was due him & the expenses have been very heavy."[72] The arena in which Greenwood chose to fight was the U.S. Court of Claims.

In addition to his negotiations with Stimers over the December 1862 redesign, Greenwood had filed a claim with the Gregory Board. The government paid him, in all, $173,327.84 for extra work, and the total paid for the *Tippecanoe* was in round figures $631,450.[73] Greenwood said in July 1864 that he had already spent at least $125,000 on "extras," so it is evident that the payments for extra work did not come near to covering the changes plus the increased costs due to inflation. Greenwood could not present his case to the Selfridge Board because his contract was not yet completed when that board met, but he did receive additional money for extras when his contract was settled in March 1866. The Marchand Board allowed him nothing, finding that none of his increased cost had been caused by the government's action. For some reason, Greenwood did not sue the government in time to meet the statute of limitations. He therefore required a private bill, which became law on March 3, 1873, to permit him to take his case to the Court of Claims. Losing no time, he filed with the court for relief on April 10, 1873.[74]

Swift & Co. was there before him. After receiving less than he desired

from the Gregory Board, Swift had submitted a private bill to Congress for relief, but the Niles Works was apparently "not willing to go to the expense of time and money required to get it through Congress." It accordingly assigned its claim to Swift and his agent, Ricker.[75] Swift later appeared before the Selfridge and Marchand boards. The former found that the two Tippecanoe-class ships had each cost Swift $114,009.94 more than the government had paid for them; as with Greenwood, the Marchand Board allowed Swift nothing additional.[76]

Swift was apparently more aware of the time limits than was Greenwood, since he needed no private bill to permit him to sue. In May 1871, Swift & Co. petitioned the Court of Claims in two separate actions, one dealing with the *Catawba* and *Oneota* and one covering the light-draft monitors *Klamath* and *Yuma*. The suits asserted that the government had delayed the construction of the vessels and thus caused Swift & Co. to have to pay increased prices for labor and materials, as well as for shops and insurance. After the suits were filed in 1871, Swift decided he had been "a large loser in the business" and left prosecution of the suits and payment of the bills for them to Ricker. The Niles Works had already declined active participation; it had had enough of the matter and would "rather pursue their business than endeavor to collect claims from the Government which was so unsatisfactory."[77]

All the shipbuilders' claims, although they varied in detail, were at root the same: because the government had delayed construction, the contractors were forced to pay inflated prices not only for changes and alterations but for the work required on the original contract. The government's responses were also the same: the contractors did not have the facilities to do the job they had said they could do; had they been fully ready to build the ships, even with the changes, they would have been done long before inflation really began to bite. In addition, the government asserted, men of "ordinary prudence and diligence" would have taken measures to protect themselves; the contractors, not the government, should pay for their bad management and lack of foresight.[78]

The evidence gathered for these cases helps to provide firsthand information about the monitor program; even Stimers, by now a consultant, gave several depositions before his death in 1876.[79] All three cases dragged on for years. Greenwood's suit moved fastest, taking just under six years from initial filing to decision. On January 13, 1879, the Court of

Claims found he was entitled to $76,730, a substantial sum, but much less than the $176,127.49 he had asked for. Much of the settlement went to pay legal expenses.[80] Despite appeals to Congress and to the courts, Greenwood never recovered enough to get back on his feet.

Swift's cases, filed in 1871, were not argued until February 1877, after which the court referred them to a pair of special commissioners for investigation. The court heard arguments again in 1878 and issued its findings in 1879. Blaming the government for most of the delays, it found that there had been no lack of diligence on the part of the contractors, and that the actual cost of construction had been considerably greater than the amount the government had paid. Both sides had tacitly disregarded the contract; the contractor had made no protest against the delays, while the government had not tried to enforce the time limit. Although the contractor had had no shipyard when it took the contract, the firm had been otherwise well equipped to build the ships for which it had bid.

Despite these findings, the Court dismissed both of Swift's suits on a point of law. Specifically, Ricker, acting as Swift's agent, had accepted the Navy's final payment and given a receipt "in full," without objection and without indicating that the amount was insufficient. Dodging the question of whether increased cost due to inflation would be a valid reason to award damages, the court opined that Swift's receipt barred the firm from later filing a separate claim for damages. Swift appealed, but because the filing did not conform to procedural rules, the Supreme Court dismissed it without a hearing.[81]

At this point, Swift & Co. turned to Congress for relief, with at least two private bills filed on its behalf, but its efforts failed and eventually it reached the point of diminishing returns.[82] Other contractors tried to obtain Greenwood-style private bills allowing referrals to the Court of Claims, but these took time to bear fruit. As the claims process dragged on, some congressmen grew testy, asking as early as 1878, "Pray when are we to have a finality?" In addition to the sheer stubbornness of some contractors in refusing to give up what they felt was due them, the Senate acknowledged a major problem: "In the different Congresses with different memberships the same old subject and ground must be gone over and over again . . . much time is wasted on each one in explanations and repetitions of ancient history."[83]

Few contractors received compensation as the direct result of a private

bill, probably because such bills made their supporters easy targets for charges of abusing public funds. As the system evolved, private bills almost always took the form of referring the matter to the U.S. Court of Claims. Many lawmakers appear to have been uneasy with the receipt defense, which smacked of the government using a legal technicality to evade its obligations rather than squarely facing the issues in court. In addition, referring an aggrieved contractor to the Court of Claims provided political cover while doing something substantial for a constituent. Yet as the "finality" complaint indicated, such cases were time consuming and frustrating. In 1890, a House committee noted that a bill for Donald McKay's heirs had passed one chamber or the other twelve times in twenty years. Most congressional committees simply quoted older reports rather than reinvestigating ad nauseam.[84]

In the early 1870s, Congress had tried to consolidate the process by referring all contractors to the Court of Claims and by permitting the court to include compensation for inflation in its awards. Unfortunately, President U. S. Grant vetoed the bill; it omitted the "ordinary prudence and diligence" requirement, and Grant objected to a law that would "relieve contractors from the consequences of their own imprudence and negligence."[85] Congress went back to legislating piecemeal, and in 1890, it was Snowdon & Mason's turn.

John N. Snowdon, the surviving partner of Snowdon & Mason, finally obtained passage of a private bill referring his claim to the Court of Claims.[86] Again, the arguments covered the same ground. Again, the Court of Claims appointed a board to investigate and eventually heard arguments. In 1893, the court awarded Snowdon $118,327.26 for the light-draft *Umpqua* and another $91,072.00 for the *Manayunk*.[87] Thirty years after they entered it, western shipbuilders were finally out of the monitor business.

Singly and in small groups, the remaining claims trickled into the Court of Claims for resolution, and in the 1890s, the court awarded damages to several claimants. The prospect appears to have awakened avarice, and at Nathaniel McKay's instigation, the Globe Works asked for compensation for the light-draft *Suncook*. One might think that every possible change would have been rung on the themes of government delay and design modifications by the time the case came to trial in the early 1900s, especially since most of the original players were dead and

many records had been destroyed or lost, but Globe based its claim solely on the amounts received by other Boston builders of light-drafts. Globe wrongly assumed, said the court, that "mutual antiquity" was enough to establish its claim, and in 1918, it dismissed the suit for "total lack of evidence."[88]

Lack of evidence was definitely not a problem in the last and longest-lived of the monitor claims. The Secors' suit in the Court of Claims culminated years of maneuvering by the brothers and their heirs, and their legal effort was on a scale comparable to their wartime (five monitors) industrial effort. The Navy's files show it: almost every document that could possibly be germane bears a red-and-white sticker with the notation, "Copied. Secor Cases."

World War I had been fought and won before the Court of Claims ruled, and the monitors that had been such bones of contention seemed decidedly antique. The court dismissed the three related "Secor cases" on March 31, 1919.[89] The harbor and river monitors themselves had all been gone for over a decade. Contrary to John Ericsson's confident prediction about their durability, the only thing about the monitors that was "good for *fifty* years" was the litigation they engendered.

CHAPTER 10

Additions, Alterations, and Improvements

Reversing Technological Momentum

The Civil War impelled changes in many areas, and the Navy's acquisition management and contracting systems evolved along with its technology. In its search for an efficient, fair, and reasonably priced acquisition system, however, the government had tinkered endlessly with its procurement.[1] Technical change was an important factor in changing the acquisition system, but far from the sole driving force.

Among nontechnological influences, the concerns of Congress were mirrored in the Navy's procurement system. The American Revolution, certainly not known for rapid technological change, saw widespread use of cost-plus rather than fixed-price contracting. The post-Revolutionary reaction against fraud and perceived excessive profits led Congress gradually to idealize competitive bidding. Well before the Civil War, this congressional stress on competition had reached the point where, by law, the secretary of the Navy's annual reports had to include not only the contracts made by Navy Department bureaus but all the unsuccessful bids as well.

The performance guarantees and reservations of the 1850s were a reaction to the Navy's loss of control of its shipbuilding, but they were as much a reaction to fear of fraud as to fear of failure. Not everyone who sought to build high-tech items could do so; some would fail honestly, but others would be less scrupulous. The government needed protection against both sorts, so the system was structured to ensure accountability and competition.[2] This carefully structured system did not work well under the pressure of war.

Part of the difficulty was that government procurement on the scale required by the Civil War dramatically overloaded the purchasing infrastructure, both physically and conceptually. The sheer volume of material to be purchased and the number of contracts to be administered overwhelmed the very small number of government employees who worked in acquisition. At the same time, the competition-above-all mentality and the slow rhythms of peacetime had to be thrown out in favor of a system that would work and work quickly.

Laudable in theory, pure competition carried prohibitive baggage under wartime conditions. In peacetime, unqualified or overly optimistic contractors could "buy into" contracts with unrealistically low bids or unrealistically early delivery dates. They would eventually fail, but since the government was bound to act as if the contractor would succeed until he actually defaulted, "buying in" resulted in delay that the government could not afford in wartime.[3] Urgency also improved the contractors' bargaining position and worsened the Navy's; desperate need made wartime shipbuilding a sellers' market in which the government would pay more than normal for its goods to expedite delivery.

To counteract these influences, the Navy tacitly disregarded some of the more onerous peacetime requirements. In purchasing engines, for example, the Navy would advertise for a few of the engines it needed and evaluate the bids it received. It would then offer contracts for identical engines, not only to the low bidder, but also to any qualified firm, at the low-bid price.[4] This method probably violated existing law, but it preserved as much as possible of the spirit of competition under the circumstances.

Engines, however, were much cheaper and easier to build than ships. Defaults by one or two firms would not seriously affect engine procurement, while one or two defaults by shipbuilding firms could cripple the ironclad program. Accordingly, in contracting for ships, the Navy needed to weed out bidders more strenuously than in contracting for engines. As shown by the deliberations of the Ironclad Board of 1861 and the awarding of the Passaic and Tippecanoe-class monitor contracts of 1862, the Navy bypassed strictly price-competitive procurement and reached out to firms that it felt could produce serviceable ironclads.

Another part of the difficulty was that the fixed-price contracts to which the Navy was accustomed worked best in a static environment.

Fixed-price contracts assumed economic stability—that prices would not change dramatically during the term of the contract. Fixed-price contracts also assumed that the articles they covered could be described by reasonably unambiguous specifications. The two factors combined to give would-be bidders clear standards by which to estimate their costs and profits.[5] Civil War ironclad shipbuilding contracts, however, suffered from the dual problems of ambiguous and fast-changing specifications and of unpredictable changes in the costs of materials and labor. Recognizing the inadequacy of fixed-price contracts in such times, civilian specialty producers such as Baldwin turned to cost-plus contracts, but the Navy never gave up the fixed-price format. The Civil War "tested the [government's] contracting process—and it barely passed."[6]

The Navy improved its contracting system under the pressure of the war. It intensified its management of the process to ensure that obviously incompetent or unqualified bidders were not given contracts and to provide inexperienced builders with the detailed plans they would need to build useful ships. It modified the provisions that described how the contracts could be changed and instituted a system for negotiating the price and schedule impact of changes before directing their accomplishment. Finally, it recognized that the reservation-centered contracting of the 1850s was counterproductive in the war's inflationary environment, and it lowered the amount of money it reserved to give contractors an infusion of badly needed cash. By 1865, the Navy was evolving toward a contracting system that promised to be better suited to acquiring the latest technologies.

Industrial mobilization also seemed promising. In its urgent need at the beginning of the Civil War, the government turned, as it had in previous wars, to private industry. It quickly (albeit quietly) modified the strict rules of competition to allow the flexibility so urgently needed in the high-technology high-stakes context of the war. Mobilizing the nation's resources by the application of economic incentives rather than by fiat, the government accepted the idea that its acquisition system should permit a contractor to make a profit. Yet the high-technology aspect of the naval war made a difference. Paul Koistinen notes that Navy procurement was small compared to Army procurement, but he misses the qualitative distinction between the two. Army procurement almost always involved mass or bulk production—vast quantities of relatively simple

items such as muskets, harness, field guns, clothing, and wagons. Manufacturers initially required capital for tooling, but once the tools were in place, little more capital was required. Navy procurement, on the contrary, was specialty production, involving limited numbers of very expensive, complex, high-technology items. Such production required not only greater amounts of capital to begin with but also steady infusions of more capital, and that capital remained tied up for some time.

Besides the capital requirements, there were knowledge requirements. War by an industrial society required more complex weapons, limiting the number of firms that could produce them. However, it is incorrect to assert that in such an industrial war, "a company could not enter the mobilization 'race' after it had begun."[7] During the twentieth century, firms with proper financing could and frequently did "enter the race" after mobilization had begun.[8] More important, these examples highlight the significant differences between mass and specialty production and the different levels of knowledge and capital required to succeed in each. The learning curve for twelve-pounder field guns, for example, was not nearly as steep as that for ironclads; Greenwood, hardly a success at building monitors, performed very well in making bronze cannon for the Army. Yet we may recognize the need for minimal levels of competence as a useful starting point.

Complicating this issue is the state of iron shipbuilding in the United States at the time. Before the Civil War, few shipyards had the facilities to build iron ships, and even fewer were more than marginally equipped. No shipyard in the country had any experience whatsoever with the sort of heavy iron construction required to build a monitor. Because of the steep learning curve and the need to expand shipyard facilities, even a leader like Harlan & Hollingsworth took twice as long to build its first monitor as it had predicted.

A further complication is that the Navy entered its industrial expansion without a clear idea of what it wanted to accomplish. Navy leadership wanted ironclads as soon as possible, but it also wanted technical perfection and cheapness. Unfortunately, even in the best case, "Good, cheap, fast—pick any two" seems to be the rule. Fox and Stimers tried to have all three and ended up barely getting one. Given that the monitor program was the country's first high-tech mobilization, it is hard to fault them for their failure to foresee the difficulties, although it is somewhat

easier to fault their failure to recognize and deal with those difficulties when they arose.

Nowhere is this failure of recognition more evident than in the western monitor program. By summer 1862, the Navy's leadership knew that the Passaic program was well behind schedule, implying that ironclad building involved what we would now call a very steep learning curve. The differences between the "established" firms (i.e., the Passaic program veterans) and the "expansion" firms figured very prominently in the monitor program. However, the contracts for the harbor and river monitors did not differentiate among them.

The firms that were Passaic veterans had gained experience (at a rate unattainable in peacetime) and established their facilities in early and mid 1862, while they could afford to do so. This timing gave the veterans a disproportionate advantage over those who joined the program later and were exposed from the first to inflation and material and labor shortages. The problems that plagued all the monitor contractors, such as late drawings, changes upon changes, shortages of capital, and inflation, were exacerbated by "one size fits all" contracts that failed to address either the difficulties faced by startup shipyards or the unique hydrographic and economic conditions of the western rivers.[9]

Both the Navy and the contractors seem to have assumed initially that shipbuilding on the Ohio River would be just like shipbuilding on the Atlantic coast. By April 1863, however, Stimers was recommending that the Navy make no effort to hold western builders to the completion dates in their contracts. Although progress reports and inspections made it clear that the quality of western-built ships was as good as that of their eastern counterparts, the more experienced and better staffed eastern yards could beat the westerners on timeliness.[10] As delays grew, by mid 1863, Secretary Welles decided that the industrial mobilization had reached its limits.

In the heady days immediately following the Battle of Hampton Roads, little thought of limits had entered the Navy's plans. "The building of a dozen Monitors is a mere trifle with the enormous engineering capabilities of the United States at this moment," Ericsson—presumed to be an expert—assured Fox.[11] When the Navy advertised for the harbor and river monitors of the Tippecanoe class five months later, however, eighteen oceanic ironclads were already in progress.[12] The Navy recognized

that building more ships would require expanding beyond the East Coast shipyards, and by that autumn of 1862, Stimers was recommending the allocation of light-draft monitors to specific shipyards based upon their workloads and capabilities.[13]

Contrary to Koistinen's thesis, high-technology production for the Civil War Navy was resource-limited, and financial mobilization alone proved insufficient. By 1863, Stimers, Fox, and Welles were thinking about explicitly allocating the industrial resources available to build ironclad ships. In mid May 1863, Stimers recommended building only one more Tippecanoe-class monitor and no more than twenty light-drafts, because "even this number disturbs the prices of both labor and iron by carrying the demand considerably above the supply." By June, Welles had come to believe that the nation's shipyards were stretched thin, and Fox told Stimers, "We have given out 20 light drafts and that ends the list. The Secretary has decided not to build any more monitors."[14] In this effort to match Navy programs to national capabilities, the monitor project office took the lead.

The project office organization, in which the general superintendent of ironclads controlled all aspects of monitor building, was a major advance in other areas as well. Its single focus allowed it to push the ironclad construction program when ironclads were most needed and to support the vessels once built. Additionally, that single focus permitted the project office to be highly responsive to the concerns of the Navy's leadership.

Yet the same single focus that permitted the project office's early successes led to failure when carried to extremes. Especially significant elements were the volume of work and the lack of independent technical review, both exacerbated by Stimers's personality and the ambiguous position of the project office relative to the Navy's command structure. When the work of the project office expanded so dramatically in 1862–63, Stimers could not do or supervise it all and still do it correctly. His concern for autonomy, however, made him resent anything that smacked of interference. After losing a few skirmishes, the bureau chiefs decided to ignore Stimers and let him succeed or fail on his own. Their action deprived the project office of meaningful technical oversight and of the safety net that a second technical opinion might have provided.

In fact, the monitor program could provide a case study in what one

contemporary student of the military-science nexus—rephrasing the timeless adage about throwing good money after bad—terms "The Law of the Rathole": "Know when to quit."[15] Fox had "married" Ericsson's technology by very publicly and wholeheartedly committing the Navy to the monitor program and failing to create a "rival rathole." The assistant secretary's early foreclosure of the variation-selection process eliminated technical competition, and his unofficial support for the monitor project office eliminated technical oversight. Within the project office, Stimers's overcentralization eliminated intraprogram competition and analysis. Stimers, who did or approved all the designing, thus had no need to defend his decisions on technical grounds. By the time Stimers's technical failures became manifest, it was too late to save the program.[16]

The assistant secretary also failed to manage expectations. "Big projects draw lots of attention," and Fox fanned the fire at every opportunity. Every news story meant that a bit more of the Navy's prestige had been invested in the monitors, and the more prestige invested, the more difficult it was to change course. Finally, both Fox and Stimers failed to monitor their subordinates: just as Stimers accepted Theodore Allen's assurances that all was well, so Fox accepted Stimers's assurances.

Welles, too, bore his share of the blame. Depending too heavily on Fox, he did not closely examine the program until the first light-draft monitor gave unmistakable evidence of failure. He assumed that Lenthall and Isherwood were as involved in the monitors as they were in other programs and that no news was good news.[17] Welles never "pulled the string" far enough to find the knots and snarls; his neglect gave ammunition to the Lincoln administration's political enemies and helped to discredit the project office system.

Aggravating all the personal failings, though, was an organizational one: Stimers depended solely upon his relationship with Fox for the influence he wielded, influence far beyond that of any other chief engineer in the Navy. Stimers probably discerned that Fox, a "live man," appreciated visible movement, and his correspondence shows that he knew that maintaining his relationship with Fox meant being responsive to Fox's concerns. While he carefully cultivated his relationship with Fox, Stimers paid no attention to building support for the monitor program elsewhere in the Navy. The general inspector correctly assessed the situation

when he wrote, "I had but one friend in the Government and that was Mr. Fox. When he deserted me I should drop out of sight immediately."[18] Stimers depended so heavily upon Fox that it affected his technical decisions, and it is possible that a formally established project office with bureau rank (such as Stimers's proposed Bureau of Iron Clad Steamers) might have prevented, or at least ameliorated, many of the problems of the monitor-building program.

Leaving aside the merits of the project office, the biggest procurement lesson for the Navy was that better is the enemy of good enough. Fox wrote of "additions and improvements and everlasting alterations, all of which have cursed our cause and our Department." The light-drafts, Fox wrote, would not be done "until the whole contest is concluded, though six of them would have given us the vitals of the South." It is easy to agree with the reason he ascribed to this: "additions, alterations and improvements."[19]

The idea of the Bureau of Iron Clad Steamers, promising as it was, foundered on the rock of the light-draft fiasco. The very public failure of a multimillion dollar program discredited Stimers and derailed his proposal. The unrelated contracting scandals and the feud between line officers and engineers ensured that the proposal would not be revived after the war. Similarly, the postwar reaction reversed the trend toward flexibility in naval acquisition. The result was a renewed exaltation of competitive bidding for government contracting and a proliferation of (marginally successful) rules to prevent fraud. Ship acquisition swung back toward an 1850s model; for a dozen years after the war, the Navy built most of its ships in its own yards.

The postwar period also brought a return to earlier ways for the companies that had been most involved in the wartime industrial mobilization. The shipbuilders' experiences support the view that much of the industrial progress engendered by the Civil War was illusory. Swift/Niles, Snowdon & Mason, and other firms, formed for the express purpose of supplying war materials, simply dissolved. Capital starvation and preoccupation with claims against the government retarded Greenwood's enterprises, as they did those of the Secors, and Greenwood's firm never regained its former stature. Eastern firms, more or less starved for capital by the many unreimbursed demands of the monitor program, also felt

the pinch. At the end of the decade, shipbuilding in Cincinnati and Pittsburgh had advanced no farther than at its beginning, and the prominent shipyards of Boston and New York were in serious trouble.[20]

The Navy, considering the industrial potential of the western states and the desirability of having shipyards where no seaborne enemy could reach them, formed the Davis commission to recommend a site for a Navy yard on the Mississippi River system. Despite the labor, material, and infrastructure advantages of places like Cincinnati and Pittsburgh, these cities could not overcome the fact that at low water, the controlling depth of the Ohio River was only 22 inches. Placing the western naval station at Mound City meant that operations would be less likely to be impeded by low water in the river system, but the Mound City area had none of the prerequisites for successful ship construction.

After the original *Monitor* and the Passaic class, the Navy ordered thirty-nine coastal and seagoing monitors. Of the nine Tippecanoe-class ships, only five were completed while the Civil War lasted. Only five of the twenty light-draft Cascos were finished by war's end. Of eight Navy-yard-built monitors of the Miantonomoh and Kalamazoo classes, only the *Monadnock* saw Civil War service, and of Ericsson's two big pets, only the *Dictator* was completed. When the war ended, twenty-seven of the thirty-nine monitors ordered after mid 1862 were still under construction. The magnitude of the resources wasted and the operational opportunities missed for lack of ships is staggering. There is plenty of blame to go around for individuals, but two institutional elements stand out: capital starvation resulting from an unsophisticated contracting policy, and an environment that permitted the age-old continuous improvement philosophy to flourish unchecked.

Civil War experience clearly showed that the continuous improvement method applied to contract-built vessels would produce ships only in time for the next war, not the current one. The institutional memory was short, however, and many lessons were lost. From 1865 through the 1870s, the Navy commenced twenty-two ships, of which only three had iron hulls. Five were built by contractors, the others in Navy yards.[21] After 1873, the Navy did not again build iron- or steel-hulled vessels until the "ABCD" ships (the cruisers *Atlanta, Boston,* and *Chicago,* and dispatch boat *Dolphin*) of 1883.

A study of Navy-business relationships demonstrates how Navy con-

tracts of the 1870s and early 1880s evolved from those of the war years. By 1871, the Navy had moved to ease the contractors' capital woes by making permanent the reduced reservation percentage instituted in 1864 and by giving contractors more frequent progress payments. The contracts for the ABCD ships similarly incorporated some clauses and refined others from earlier contracts, mostly in ways that increased the Navy's control of the shipbuilding process or protected the government's interests.[22]

Despite this contractual progress, the ABCD effort indicates that the Navy had not internalized key lessons of the monitor program. First, the Navy put up the ships for bids before the plans were completed. Next, rigid pro-competition laws forced the Navy to award all four of the ABCD contracts to the low bidder, John Roach of Chester. During construction, Roach suffered from careless or late preparation of drawings by the Navy and a constant stream of additions, alterations, and improvements. Thanks to delays and the growing amount of rework required, Roach's capital ran short, and he had difficulty paying his workforce, slowing the work and further delaying progress payments.

In 1885, William C. Whitney, the newly appointed (Democratic) secretary of the Navy, withheld payments due to the (Republican) contractor, Roach, who was forced into bankruptcy.[23] Thanks to even more design changes, the Navy took twenty-two more months to finish the nearly completed ships after it took over Roach's shipyard. It was "déjà vu all over again." The institutional consequences of the Civil War mobilization were as ephemeral as the physical ones.

The fate of the wartime acquisition system displays the "conservative reaction" of accumulated sociotechnical momentum. "Once the disruptive force—in this case, war—is removed, the prewar context again prevails," Thomas Hughes observes. In the peacetime context of the post–Civil War period, the Navy had neither the resources nor the inclination to continue to employ a "wartime style of technology" involving "accelerated economies of scale and capital-intensive technology."[24] Yet the prewar peacetime context had been one of cautious experiment and progress. Using the concepts of momentum and conservative reaction, one might suppose that the breakneck pace of wartime technological advance would have slowed but not stopped once hostilities ended. Progress should have continued, but at a slower rate. Instead of continuing to make slow progress,

or even to stand still, however, postwar Navy shipbuilding technology regressed, returning primarily to wooden ships built in Navy yards. Resolving this seeming contradiction requires a closer look.

A nation "does not walk away unchanged from its large technological projects," Hughes notes, and neither does an organization.[25] Large projects help to redirect technological momentum, whether they involve electronic computers or large central power plants. To extend the analogy, however, momentum equals mass times velocity, and velocity is a vector quantity. Technological momentum will be affected differently by failure than by success. Successful projects, like electrification, the ICBM project, the nuclear propulsion program, and the Polaris Fleet Ballistic Missile program, leave positive feelings and successor programs in their wakes—they redirect technological momentum in ways consistent with their own characteristics as others try to emulate their successes.

Unsuccessful programs also redirect technological momentum, but in the opposite direction. Combining the natural backlash with the stigma of failure intensifies the conservative reaction against a program, and more particularly against the elements perceived as having caused it to fail. Increasing the size of the program and the perceived degree of its failure tends to increase the intensity and duration of the reaction.[26]

Many constituencies perceived the Civil War ironclad program to be more or less a failure. At the Navy Department level, Welles was extremely unhappy with the light-draft monitors and with the delays and cost overruns in building other ironclads. He felt ill served by the men who managed the monitor program: Fox and Stimers most of all, but Lenthall, Isherwood, and Gregory as well. His postwar testimony to the House committee that investigated Secretary of the Navy George M. Robeson also indicated his displeasure with the way the monitor project office managed the program's relationships with contractors. In the technical bureaus, Lenthall and Isherwood predictably disparaged the monitor program and its management, and even Fox had to agree that additions, alterations, and improvements had crippled ironclad acquisition.

In the officer corps, line officers focused some of their resentment of engineers on the machinery-packed monitors, and there seems to have been residual anti-monitor feeling among officers who believed that the Navy Department had sacrificed Du Pont to the "monitor men." Even engineers were far from unanimous in their approval of the late monitor

bureau; Stimers had too frequently played politics and encouraged partisanship by seeking to supplant Isherwood.

Outside the Navy, congressmen resented the waste of money represented by the unused monitors (although as Welles pointed out, some would attack the Navy no matter what), and congressional assaults on Navy management continued for years. The ironclad contractors, meanwhile, pressed their claims for more money, and most of them based those claims upon assertions of poor management by the Navy.

A century later, a chronicler of the Polaris Fleet Ballistic Missile program could confidently but incorrectly assert that until Polaris, the Navy "had not previously formed a major subunit whose sole mission was the development of a single weapons system."[27] There were many parallels between Vice Admiral William F. Raborn's Special Projects Office and Stimers's General Inspectorate, but one really glaring difference: the Polaris program succeeded, whereas the monitor program failed. Stimers's failure discredited "project management" in the Navy so badly that it disappeared for eighty years; Polaris's success made the "project office" all the rage. Each diverted technological momentum in its own direction.

It is difficult to escape the conclusion that bureaucratic and "people skills" made the difference. Both programs began with technological and "systems integration" problems, with considerable support in the civilian Navy secretariat, with very high priorities and with large claims upon the Navy's and the nation's resources. Almost from their beginnings, however, they diverged. Admiral Raborn understood the need to wield influence sparingly—that too-frequent recourse to high officials would wear out the program's welcome. He responded to internal opposition by co-opting it, absorbing elements of other programs to prevent threats. He knew that maintaining autonomy required short-term concessions to build long-term support. He also knew that it would be much easier to maintain autonomy if the Special Projects Office gained a reputation for managerial competence, and he structured the Polaris program so that intraprogram competition would provide searching analysis and a range of alternatives for each major decision.

Stimers did none of these things. At every check, the general inspector ran to Fox with his problems, eventually forcing the latter to "make difficult choices at a pace [he] could not long sustain." Far from co-opting internal opposition, Stimers seems to have enjoyed conflict; he rammed

the monitor program down the throats of the rest of the Navy, even threatening court-martial charges against Lenthall for "having presumed to reprimand me" over an engineering issue. Refusing to make concessions, he instead made enemies—for Stimers, it was my way or the highway, and the insulting tone of some of his letters only made matters worse. His consolidation of decision-making robbed the monitor program of the benefits of internal competition and of the safety net provided by a technical "second look."

When Stimers became the general inspector in 1862, the monitor program enjoyed public esteem, official favor, and a high reputation; as Fox later wrote, the country was "willing to give us anything and everything" in return for success.[28] Stimers's bureaucratic and personal failings contributed much to draining that enormous reservoir of goodwill, prestige, and official backing, while the December 1862 major redesign of the Tippecanoe class began to erode the "monitor bureau's" reputation for technical and managerial competence. As opposition to the General Inspectorate grew, Stimers had to turn ever more frequently to Fox, but as the program slipped farther and farther behind, he had less and less to show for the resources and influence Fox supplied. The light-draft fiasco finally tipped the balance away from the project office, and when it tipped, it tipped all the way. In the 1960s, the success of the Polaris Special Projects Office undermined the Navy's confidence in the bureau system. In the 1860s, Stimers's failure destroyed the reputation of the "monitor project office" and exalted that of the bureaus for years to come.

As the Navy's ironclad acquisition system evolved during the war, its rapid but uneven expansion created reverse salients; when it shrank after the war, it left salients behind, the way an ebbing tide leaves pools. Management and contracting became salients rather than reverse salients, ahead of the Navy's requirements rather than behind them, and both of them were more or less tainted by failure as well. With such a taint, neither the wartime style of technology nor the prewar climate of cautious progress could prevail once the Confederacy's collapse removed the disruptive force of the war. The expensive and public failure of a project as large as the monitor program redirected the U.S. Navy's technological momentum for a generation.

Appendix

Tabular Data for Passaic- and Tippecanoe-Class Monitors

Passaic-Class Monitors

Ship	*Contractor*	*Hull*	*Machinery*	*Contract*	*Paid*
Passaic	Ericsson	Continental	Delamater	$400,000	$423,172
Montauk	Ericsson	Continental	Delamater	$400,000	$423,027
Patapsco	Ericsson	Harlan & H'worth	Harlan & H'worth	$400,000	$422,780
Catskill	Ericsson	Continental	Delamater	$400,000	$427,767
Sangamon	Ericsson	Reaney, Son & Archbold	Morris & Towne	$400,000	$422,767
Lehigh	Ericsson	Reaney, Son & Archbold	Morris & Towne	$400,000	$422,726
Nahant	Loring	City Pt	City Pt	$393,000	$413,515
Weehawken	Secor	Colwell	Fulton	$400,000	$436,007
Nantucket	Curtis	Atlantic	Atlantic	$386,000	$408,091
Camanche	Donohue, Ryan & Secor	Colwell	Fulton	$565,000	$792,165

Harbor and River Monitors

Name	*Builder*	*Launched*	*Commissioned*	*Price Paid†*	*Fate*
Canonicus	H. Loring	8/1/63	4/16/64	$661,476	Sold 1908
Catawba	Swift/Niles	4/13/64	6/10/65*	$621,424	Sold 1868
Mahopac	Secor	5/17/64	9/22/64	$701,624	Sold 1902

Harbor and River Monitors (*continued*)

Name	*Builder*	*Launched*	*Commissioned*	*Price Paid*†	*Fate*
Manayunk	Snowdon & Mason	12/18/64	9/27/65*	$717,654	Sold 1899
Manhattan	Secor	10/14/63	6/6/64	$701,624	Sold 1902
Oneota	Swift/Niles	5/21/64	6/10/65*	$621,424	Sold 1868
Saugus	Harlan & H'worth	12/16/63	4/7/64	$498,513	Sold 1891
Tecumseh	Secor	9/12/63	4/19/64	$701,624	Sunk 1864
Tippecanoe	Greenwood	12/22/64	2/15/66*	$710,058	Sold 1899

* Indicates acceptance rather than commissioning date.

† Contract price for all ships was $460,000.

NOTE: The "harbor and river monitors" are known by various class names, including *Canonicus* (the first of the class to be launched and the longest-lived), *Saugus* (the first to be commissioned), and *Tecumseh* (the first to be sunk). Most contemporary documents refer to them as the Tippecanoe-class. In June 1869, Admiral David D. Porter caused a wholesale renaming with mythological or "heroic" names. Another wholesale renaming took place later the same year. In the latter, most ships received their original names again, but enough did not to trip the unwary. Of the harbor and river monitors, *Tecumseh* had been sunk and *Catawba* and *Oneota* sold to Peru, so the 1869 renamings were:

Original	*June 1869*	*August 1869*
Canonicus	*Scylla*	*Canonicus*
Mahopac	*Castor*	*Mahopac*
Manayunk	*Ajax*	*Ajax*
Manhattan	*Neptune*	*Manhattan*
Saugus	*Centaur*	*Saugus*
Tippecanoe	*Vesuvius*	*Wyandotte*

Abbreviations

Battles and Leaders	*Battles and Leaders of the Civil War*, ed. Robert Underwood Johnson and Clarence Clough Buel (4 vols.; 1884–88; reprint, New York: Castle Books, 1956, 1991)
Butler Diary	John M. Butler Diary, 1862–64, MS 3947 (microfilm), Western Reserve Historical Society, Cleveland, Ohio
Correspondence of Fox	*Confidential Correspondence of Gustavus Vasa Fox, Assistant Secretary of the Navy, 1861–1865,* ed. Robert Means Thompson and Richard Wainwright (2 vols., 1918–19; reprint, Freeport, N.Y.: Books for Libraries Press)
CtClms	Court of Claims published decisions
Du Pont Letters	*Samuel Francis Du Pont: A Selection from His Civil War Letters,* vol. 1: *The Mission, 1860–1862;* vol. 2: *The Blockade, 1862–1863;* vol. 3: *The Repulse, 1863–1865,* ed. John D. Hayes (Ithaca, N.Y.: Cornell University Press for the Eleutherian Mills Historical Library, 1969)
Ericsson Papers	John Ericsson Papers, American Swedish Historical Foundation (microfilm)
Fox Papers	Naval Historical Society Collection, Gustavus Fox Papers, New-York Historical Society, New York
Light Draught Monitors	U.S. Congress, *Report of the Joint Committee on the Conduct of the War, Thirty-eighth Cong.,* 2d sess. (Washington, D.C.: GPO, 1865), "Light Draught Monitors"
NA	National Archives and Records Administration
NARG	NA Record Group

OR	*The War of the Rebellion: A Compilation of the Official Records of the Union and Confederate Armies* (Washington, D.C.: GPO, 1880–1901)
ORN	*Official Records of the Union and Confederate Navies in the War of the Rebellion* (Washington, D.C.: GPO, 1894–1922)
Report . . . Armored Vessels	*Report of the Secretary of the Navy in Relation to Armored Vessels,* House Executive Document 69, 38th Cong., 1st sess., 1864
R. G. Dun	R. G. Dun & Co. Collection, Baker Library, Harvard Business School
Welles Papers	Papers of Gideon Welles, Library of Congress, Washington, D.C. (microfilm)

Notes

Introduction

1. A "class" is a group of ships built to the same design. Class members ("sister ships") may be almost identical, although minor variations are inescapable in such complex structures. Over time, accumulated alterations or reconstructions may fragment a class, and classes may be as small as one ship. In this work, *Monitor* refers to the original USS *Monitor* only, while "monitor" or "monitors" is a generic term for armored vessels of very low freeboard, bearing guns mounted in turrets. Major design variations (classes) discussed include the Passaic class of coastal monitors, the Tippecanoe class of "harbor and river" monitors, and the Casco class of "light-draft" monitors. Normally, a class takes its name from its first ship.

2. Thomas P. Hughes, *Networks of Power: Electrification in Western Society, 1880–1930* (Baltimore: Johns Hopkins University Press, 1983), 5; id., *Rescuing Prometheus* (New York: Pantheon Books, 1998), 58.

3. See Walter G. Vincenti, *What Engineers Know and How They Know It: Analytical Studies from Aeronautical History* (Baltimore: Johns Hopkins University Press, 1990), 48.

4. Hughes, *Networks of Power*, 5.

5. U.S. Comptroller General, *Report to the Congress: Outlook for Production on the Navy's LHA and DD-963 Shipbuilding Programs* (B-163058), July 26, 1973, 1. The contractor was Litton Industries.

Chapter 1. "I Have Shouldered This Fleet": Gustavus Fox and "Monitor Mania"

1. David George Surdam, "Northern Naval Superiority and the Economics of the American Civil War" (Ph.D. diss., University of Chicago, 1994), 4, 8-9, 13. Theodore Ropp, "Anacondas Anyone?" *Military Affairs* 27 (Summer 1963): 71–76.

2. U.S. War Department, *An Atlas to Accompany the Official Records of the Union and Confederate Armies, 1861–1865* (1891–95; rpt., New York: Fairfax Press, 1978), pl. 137.

3. The Navy Department's organization was established by law in 1842. It comprised five "bureaus," each responsible for a functional area of naval administration: Yards and Docks; Construction, Equipment and Repairs; Provisions and Clothing; Ordnance and Hydrography; and Medicine and Surgery. The bureau chiefs (some civilians, some naval officers) reported directly to the secretary of the Navy.

4. Welles to Joseph Smith, May 30, 1861, in National Archives (NA), Record Group 45, Office of Naval Records and Library, entry 464, subject file, U.S. Navy, 1775–1910 (hereafter "NARG 45, subject file"), OL—Mobilization and Demobilization, box 412, Minutes of Board of Bureau Chiefs on Subjects of Supplying Blockading Squadrons; minutes of meetings of May 30, May 31, and June 1, 1861.

5. Samuel Novotny, "The Board of Strategy and Union Military Planning for Sea Operations Against the Southern Confederacy" (M.A. thesis, Old Dominion University, 1978), 3–4; NARG 45, subject file, ON—Operations, box 453, Rough Drafts of Proceedings and Reports of the Blockade Strategy Board.

6. Du Pont to Henry Winter Davis, June 1, 1861, *Du Pont Letters,* 1: 75. The conference superseded the board of bureau chiefs. The chiefs' meetings became weekly in late June and the last minutes are dated July 30, 1861. NARG 45, subject file OL, Minutes of Board of Bureau Chiefs.

7. Du Pont to Sophie M. Du Pont, June 28, 1861, in *Du Pont Letters,* 1: 85–86. Three Atlantic Coast reports are in *ORN;* first, *ORN* 12: 195–98; third (labeled second), ibid., 198–201; fourth (labeled third), ibid., 201–6. The actual second report is in *OR,* ser. 1, 53: 67–73. The Gulf reports are *ORN* 16: 618–30, 651–55, and 680–81.

8. Welles to Du Pont, Aug. 3, 1861, *ORN* 12: 207.

9. Mallory to C. M. Conrad, May 10, 1861, *ORN,* ser. 2, 2: 69. William N. Still Jr., *Iron Afloat: The Story of the Confederate Armorclads* (Columbia: University of South Carolina Press, 1985), 5–17, 19; James Phinney Baxter III, *The Introduction of the Ironclad Warship* (Cambridge, Mass.: Harvard University Press, 1933; rpt., Hamden, Conn.: Archon Books, 1968), 229; Raimondo Luraghi, *A History of the Confederate Navy* (Annapolis, Md.: Naval Institute Press, 1996), 61–69.

10. Gideon Welles, *Diary of Gideon Welles, Secretary of the Navy under Lincoln and Johnson,* ed. Howard K. Beale (New York: Norton, 1960), 1: 65; Still, *Iron Afloat,* 5–17, 19; Baxter, *Ironclad Warship,* 229; George M. Brooke Jr., *John M. Brooke: Naval Scientist and Educator* (Charlottesville: University Press of Virginia, 1980), 232–42.

11. As early as June 1, 1861, the bureau chiefs discussed, "1st whether ironclad vessels are needed & 2nd, if so, which if any of the various plans known, or

presented to the Dept, [should] be selected, or approved for trial." NARG 45, subject file OL, Minutes of Board of Bureau Chiefs.

12. *Report . . . Armored Vessels,* 1–2. This ironclad appropriation equaled 13 percent of the Navy's last prewar (1860) budget. Boards (i.e., committees) of officers frequently investigated technical or administrative questions or apportioned responsibility. Although far from impervious to "command influence," boards were perceived as minimizing favoritism and animosity. By incorporating collective input, this traditional administrative device reduced the chance of technical error while providing some bureaucratic "cover" for decision-makers.

13. NARG 45, subject file, AC—Construction of US Ships, box 22, Advertisements.

14. Donald McKay offered to build an ironclad for an even million dollars, and Renwick wanted the whole million and a half. NA Record Group 19, Records of the Bureau of Ships, Plan File, Bureau of Ships (BuShips) Plan 80-11-3.

15. On the *Galena* and her construction, see Kurt Henry Hackemer, "From Peace to War: U.S. Naval Procurement, Private Enterprise, and the Integration of New Technology, 1850–1865" (Ph.D. diss., Texas A&M University, 1994), and *The U.S. Navy and the Origins of the Military-Industrial Complex, 1847–1883* (Annapolis, Md.: Naval Institute Press, 2001), 83–87.

16. *Report . . . Armored Vessels,* 5.

17. Merrick & Sons estimated that it would cost $780,000 and take nine months to build its ship, as against Ericsson's estimate of $275,000 and 100 days.

18. Mallory urged both courses upon Flag Officer Franklin Buchanan. Mallory to Buchanan, Feb. 24, 1862, *ORN* 6: 776–77; Mallory to Buchanan, Mar. 7, 1862, ibid., 780–81.

19. The seagoing qualities of the Merrimack class were highly regarded. John D. Alden, "Born Forty Years Too Soon," *American Neptune,* no. 4 (Oct. 1962): 252–53. Welles's low opinion of the *Virginia*'s seaworthiness may have been strengthened by hindsight. Welles, *Diary,* 1: 65.

20. Anonymous to Welles, no date (about Mar. 14, 1862), NARG 45, entry M124, Miscellaneous Letters Received by the Secretary of the Navy, roll 401, Mar. 13–20, 1862, 31.

21. Welles, *Diary,* entry for July 24, 1865, 2: 341.

22. Vincenti, *What Engineers Know and How They Know It,* 48–49, 241–50. While superficially similar to "trial and error" tinkering, some variation-selection episodes result in "trial and success," and both successes and failures expand the general knowledge base. Variation-selection in the ironclad program

is discussed in William H. Roberts, " '*The name of Ericsson':* Political Engineering in the Union Ironclad Program 1861–1863," *Journal of Military History* 63 (Oct. 1999): 823–44, and *USS New Ironsides in the Civil War* (Annapolis, Md.: Naval Institute Press, 1999), 5–7, 113.

23. The Royal Navy, for example, experimented with many ironclad designs—armored frigates, central battery ships, high- and low-freeboard turret ships, and breastwork monitors—before settling on a "standard battleship" in the 1890s.

24. Ericsson listed his design considerations in "The Building of the 'Monitor,' " in *Battles and Leaders,* 1: 731–32.

25. Francis B. Wheeler, *John F. Winslow, LL.D. and the Monitor* (Poughkeepsie, N.Y.: n.p., 1893), 53–54. From calculations dated Feb. 11, 1862, Ericsson expected about $20,000 as his share of the profit, plus $5,000 as an "Engineer & patent fee." Ericsson Papers, reel 4.

26. Baxter, *Ironclad Warship,* 277–79; William Conant Church, *The Life of John Ericsson* (2 vols.; New York: Charles Scribner's Sons, 1891), 1: 257–59. William N. Still Jr., *Monitor Builders: A Historical Study of the Principal Firms and Individuals Involved in the Construction of USS Monitor,* (Washington, D.C.: National Park Service, 1988), 29.

27. Wheeler, *Winslow,* 34–35; *The Real Facts concerning John A. Griswold and the Building of the Monitor* (n.p., 1868), in Pamphlets relating to the Presidential Election of 1868 (microfilm, oclc.org accession no. 31433148); William S. Wells, *The Original United States Warship Monitor* (2d ed., New Haven, Conn.: Cornelius S. Bushnell National Memorial Association, 1906).

28. The Bureau of Steam Engineering was formed in July 1862, but Isherwood was for practical purposes a bureau chief by mid 1861. Edward William Sloan III, *Benjamin Franklin Isherwood, Naval Engineer: The Years as Engineer in Chief, 1861–1869* (Annapolis, Md.: Naval Institute Press, 1965), 28–29. NARG 19, Plan File, BuShips Plan 142–10–14, "Specifications of the Iron Armature and Other Exterior Iron Work of a Steam Battery to be Constructed for the United States," and "Building Instructions for an Iron-Clad Steam Battery." NARG 45, entry M518, Letters Received by the Secretary of the Navy from Navy Department Bureaus, reel 17, Lenthall, Isherwood et al. to Welles, May 10, 1862.

29. U.S. Navy Department, *Annual Report of the Secretary of the Navy, 1860–61* (Washington, D.C.: GPO, 1861), 22. Paul Studenski and Herman E. Kroos, *Financial History of the United States,* 2d ed. (New York: McGraw-Hill, 1963), 125, 152.

30. For 1861 legislation, see *Report . . . Armored Vessels,* 1. *Congressional Globe,* 37th Cong., 2d sess., 123.

31. NARG 19, Plan File, BuShips Plan 142-10-14 bears the handwritten date "Dec 20th 1861."

32. *Cincinnati Daily Commercial,* Jan. 1, 1862, 3.

33. Church, *Life of John Ericsson,* 1: 234. Du Pont found Ericsson a man of genius and honesty, but "he never succeeded in anything in his life." Du Pont to Henry Winter Davis, May 3, 1863, *Du Pont Letters,* 3: 77.

34. Ericsson to John Bourne, May 15, 1866, quoted in Church, *Life of John Ericsson,* 2: 72. David A. Mindell, *War, Technology, and Experience aboard the USS Monitor* (Baltimore: Johns Hopkins University Press, 2000), 32–41, 116–122. Ericsson to Fox, Apr. 23, 1866, calls Isherwood, "one of the most unfair persons" in the profession (Ericsson Papers, reel 3). Coles's "abortive" turret: Ericsson to Welles, Dec. 17, 1861, quoted in Baxter, *Ironclad Warship,* 277.

35. Ericsson to Welles, Dec. 23, 1861, in Baxter, *Ironclad Warship,* 358–60. The ships were to cost $325,000 apiece, compared to $275,000 for the original *Monitor*. Corning to Welles, Dec. 25, 1861, reprinted ibid., 278.

36. Winslow to Ericsson, Jan. 6, 1862, Baxter, *Ironclad Warship,* ibid., 279. If the ship succeeded, "other plans and other contractors *will be nowhere.* Our 'prestige' will be hard for others to overcome." Winslow to Ericsson, Jan. 10, 1862, in Church, *Life of John Ericsson,* 2: 2.

37. Winslow to Ericsson, Jan. 10, 1862, quoted in Church, *Life of John Ericsson,* 1: 277–78. John D. Hayes, "Captain Fox—*He* Is the Navy Department," *United States Naval Institute Proceedings* 91, no. 9 (Sept. 1965): 65–67; William J. Sullivan, "Gustavus Vasa Fox and Naval Administration" (Ph.D. diss., Catholic University of America, 1977).

38. *Congressional Globe,* 37th Cong., 2d sess., 219–21, 245–49. Hale charged Welles with nepotism; Welles saw Hale as venal and corrupt. Richard H. Sewell, *John P. Hale and the Politics of Abolition* (Cambridge, Mass.: Harvard University Press, 1965), 197–207.

39. Welles to Hale, Feb. 3, 1862, Welles Papers, container 20, Correspondence Jan.–Feb. 1862.

40. Welles to Hale, Feb. 7, 1862, NARG 45, entry 5, Letters to Congress, vol. 11, labeled on spine "No. 13 Jan. 3, 1855 to May 12, 1862." For Corning's involvement, see Irene D. Neu, *Erastus Corning, Merchant and Financier, 1794–1872* (Ithaca, N.Y.: Cornell University Press, 1960), 55.

41. Bushnell to Ericsson, Feb. 26, 1862, in Church, *Life of John Ericsson,* 2: 3. Fox said Hale "kept [the bill] in his pocket for two months," and Welles called Hale "corrupt, a rogue as well as a buffoon." Fox to Joseph S. Fay, Nov. 25, 1862, *Correspondence of Fox,* 2: 455; Welles, *Diary,* entry for Dec. 1863, 1: 483. Hale's

biographer adduces only "circumstantial evidence" that Hale was bought. Sewell, *John P. Hale,* 202, 199.

42. NARG 19, entry 405, Proposals and Advertisements of Sales. Welles, *Diary,* 1: 62–65, and Robert J. Schneller, *A Quest for Glory: A Biography of Rear Admiral John A. Dahlgren* (Annapolis, Md.: Naval Institute Press, 1996), 197–99; Madeleine Vinton Dahlgren, *Memoir of John A. Dahlgren, Rear Admiral United States Navy* (Boston: James R. Osgood and Co., 1882), 358–61.

43. *Aboard the USS Monitor: 1862: The Letters of Acting Paymaster William Frederick Keeler, U.S. Navy to his Wife, Anna, ed.* Robert W. Daly (Annapolis, Md.: Naval Institute Press, 1964), 42, 47, 53, 57, 65–66, inter alia; Earl J. Hess, "Northern Response to the Ironclad: A Prospect for the Study of Military Technology," *Civil War History* 31 (1985): 126–43; David A. Mindell, " 'The Clangor of That Blacksmith's Fray': Technology, War, and Experience Aboard the USS *Monitor,*" *Technology and Culture* 36, no. 2 (Apr. 1995): 268.

44. Du Pont to William Whetten, Mar. 17, 1863, *Du Pont Letters,* 2: 489. "The *Galena* and *Ironsides* are the work of the blacksmith; the *Monitor* a piece of delicate, perfect mechanism" (Fox to Ericsson, Aug. 5, 1862, Ericsson Papers, reel 4).

45. George E. Belknap, "Reminiscent of the Siege of Charleston," in *Naval Actions and History, 1799–1898* (Boston: Military Historical Society of Massachusetts, 1902), 188. Fox to Ericsson, Dec. 30, 1862 (unofficial, typescript), Fox Papers, box 3. On Mar. 14, 1862, Winslow told Corning of contracts for six monitors at $400,000 each (up from $325,000 in December 1861 to $400,000 after Hampton Roads). Neu, *Erastus Corning,* 55.

46. *Annual Report of the Secretary of the Navy, 1861–62,* 31.

47. Hackemer, "From Peace to War," 213. The $780,000 contract far exceeded Merrick & Sons' capital. Pennsylvania Vol. 135, p. 320, R. G. Dun & Co. Collection, Baker Library, Harvard Business School. Merrick & Sons to Fox, June 2, 1862, NARG 45, entry M124, roll 409, 14.

48. Augustus C. Buell, *The Memoirs of Charles H. Cramp* (Philadelphia: J. P. Lippincott Co., 1906), 72, 81.

49. Builders in the New York metropolitan area (which included Jersey City, N.J., and Greenpoint, N.Y.) built or subcontracted twelve of the first fourteen vessels and fifteen of the first twenty-three. U.S. Navy, Naval History Division, *Monitors of the U.S. Navy, 1861–1937* (Washington, D.C.: GPO, 1969), 10–23. Two Passaic-class contracts went to Boston because of political agitation. Barbara B. Tomblin, "From Sail to Steam: The Development of Steam Technology in the United States Navy, 1838–1865" (Ph.D. diss., Rutgers University, 1988), 295.

50. Welles, *Diary,* entry for July 25, 1868, 3: 413. Braces {} indicate later additions or changes by Welles.

51. NARG 45, entry M518, Lenthall, Isherwood, Hartt, and Martin to Welles, May 10, 1862. The Passaic-class ships were initially called "improved *Monitor*s" or "coastal monitors." By late 1862, as has been noted, "monitor" was a common noun and class names were in use.

52. The final score for the Passaic class was Ericsson, six, including three subcontracted to firms in Wilmington and Chester; other New York builders, two; Boston builders, two. Naval History Division, *Monitors,* 10–12.

53. Multiple turrets were anathema to Ericsson. Ericsson to Fox, Aug. 5, 1863, Ericsson Papers, reel 3. The Miantonomohs had wood hulls (because Navy yards could not build iron hulls), Ericsson turrets, and laminated armor. Donald L. Canney, *The Old Steam Navy,* vol. 2: *The Ironclads, 1842–1885* (Annapolis, Md.: Naval Institute Press, 1993), 65–66.

54. The *Keokuk,* sunk by Confederate guns, was one of the "variations that when overtly tried do not in fact work" (Vincenti, *What Engineers Know,* 246).

55. Welles addressed Hale and Congressman Charles B. Sedgwick, chairmen of the Senate and House naval committees, on Mar. 25, 1862. He asked for $30,000,000 (including the $10,000,000 already appropriated) to build ironclads and heavy ordnance, and to armor existing vessels. Welles to Hale and Sedgwick, Mar. 25, 1862, NARG 45, entry 5, vol. 11. The Navy received $13 million from a supplemental appropriation enacted Apr. 17, 1862. *Congressional Globe,* 37th Cong., 2d sess., 1393–1403, 1418–31, 1608–12.

Chapter 2. Forging the Fleet: General Inspector Alban C. Stimers and the Passaic Project

1. Church, *Life of John Ericsson,* 1: 261.

2. Howard I. Chapelle, *The History of the American Sailing Navy: The Ships and Their Development* (rpt., New York: Bonanza Books, 1949), 371–425.

3. Hackemer, "From Peace to War," 39, 62–63; id., *The U.S. Navy and the Origins of the Military-Industrial Complex,* 60–66. Frank M. Bennett, *The Steam Navy of the United States* (1896; rpt., Westport, Conn.: Greenwood Press, 1974), 141, 894–95. Hackemer, "From Peace to War," 260–62.

4. NARG 71, Records of the Bureau of Yards and Docks, entry 42, Contracts and Bonds 1861, 269–70.

5. Hackemer, "From Peace to War," 229; id., *The U.S. Navy and the Origins of the Military-Industrial Complex,* 92–95.

6. *New Ironsides*'s contract, NARG 71, entry 42, 269–71. The *Galena*'s contract stated, "any immaterial [*sic*] improvements which the said parties may agree to, as the vessel progresses, may be made without prejudice to principal points in this contract." Hackemer, "From Peace to War," 158.

7. The Bureau of Construction, Equipment and Repairs was responsible for building Navy ships, but Welles gave the first ironclads to Joseph Smith's Bureau of Yards and Docks, apparently because of Smith's connection with the Ironclad Board.

8. Joseph Smith to William H. Webb, Aug. 8, 1862, NARG 45, subject file AD—Ironclads, box 51 (typescript marked "Naval War Records [NWR] 2634:367").

9. Church, *Life of John Ericsson,* 1: 270.

10. Gregory discusses his appointment in Light Draught Monitors, 73. He was made rear admiral on July 16, 1862. For gunboat contracts, see Hackemer, *The U.S. Navy and the Origins of the Military-Industrial Complex,* 99–107.

11. Julia Stimers Durbrow, *The Monitor and Alban C. Stimers* (Orlando, Fla.: Ferris Printing, 1936), 19; Dana M. Wegner, "Alban C. Stimers and the Office of the General Inspector of Ironclads, 1862–1864" (M.A. thesis, State University of New York College at Oneonta, 1979), 5. Engineers progressed from third, second, and first assistant engineer to reach the rank of chief engineer. Under an 1859 law, chief engineers ranked with line commanders.

12. NARG 24, entry 181, Ship Books Containing Complements and Rosters of Officers on Vessels, s.v. "*Merrimack.*" Wegner, *Alban C. Stimers,* 3–4. Joseph Smith to Stimers, Nov. 5, 1861, in Durbrow, *The Monitor and Alban C. Stimers,* 1–2. Stimers to "My Dear Father," Mar. 11, 1862, ibid., 11–12. Also Stimers to "My Dearest Wife," Mar. 8, 1862, ibid., 6–7.

13. Commissioned officers in the Navy were divided into two classes, line and staff. Line officers were generalists who sailed, fought, and commanded ships; staff officers were specialists who were not eligible for command at sea. During the Civil War, the staff comprised engineers, doctors, paymasters (supply officers) and naval constructors.

14. Samuel D. Greene, "In the 'Monitor' Turret," in *Battles and Leaders,* 1: 719–29. Fox to Welles, Mar. 8, 1862, *ORN* 7: 6, and Fox to Ericsson, Mar. 9, 1862, ibid., 7; Fox to Stimers, Mar. 10, 1862, in Durbrow, *The Monitor and Alban C. Stimers,* 10. John Barnes, quoted in Wegner, *Alban C. Stimers,* 4.

15. Stimers had been thinking about improvements for some time. Stimers to Fox, Feb. 3, 1862, Fox Papers, box 4; Stimers to Fox, Apr. 14, 1862, ibid. Fox to Goldsborough, Mar. 24, 1862, *Correspondence of Fox,* 1: 252; Goldsborough to Fox, Mar. 25, 1862, Fox Papers, box 3 (Goldsborough's emphasis). Stimers to Fox, Apr. 14, 1862, from Hampton Roads, Fox Papers, box 4. Stimers wrote from New York on Apr. 24.

16. Stimers to Fox, Apr. 24, Fox Papers, box 4. Ericsson saw Stimers's plans, probably without the latter's knowledge, and called them "utterly defective." He asked Fox not to require a formal report that would hurt "my excellent friend"

Stimers. Ericsson to Fox, Apr. 23, 1862 (private, typescript), ibid., box 3. The episode reflects both Ericsson's egotism (he called Stimers's proposal "a great breach of professional courtesy") and Stimers's inexperience as a designer.

17. Gregory to Welles, May 10, 1862, NARG 19, entry 1235, Correspondence of the General Superintendent of Ironclads, 18: 41.

18. Gregory to Stimers, May 23, 1862, NARG 19, entry 1235, 18: 42. Fox probably did not seriously consider Stimers for the higher post. The general superintendent needed "clout"; as a line admiral, even on the retired list, Gregory had far more clout than Stimers, a staff officer whose relative rank equaled that of a commander.

19. Light Draught Monitors, 74. Deposition of Alban C. Stimers, Aug. 11, 18, and 19, 1873, NA, Record Group 123, Records of the Court of Claims, entry 1, General Jurisdiction Case Files, case[s] 6326/6327, Swift v. United States. Case 6326 is "Alexander Swift et al. v. United States," dealing with the light-draft monitors *Klamath* and *Yuma;* case 6327 is "Alexander Swift and the Niles Works v. United States," dealing with the harbor and river monitors *Catawba* and *Oneota.* Principles, arguments, and evidence were commingled. For brevity, such items will be cited as "Cases 6326/6327, Swift v. United States."

20. *ORN* 23: 141. Captain Joseph Hull, like Gregory, was called back from retirement; he was promoted to commodore on July 16, 1862.

21. The 15-inch guns could not be manufactured in time, so all the Passaics except *Camanche* received one 15-inch and either an 11-inch Dahlgren smoothbore or a 150-pounder Parrott rifle. Naval History Division, *Monitors,* 10.

22. Welles to John P. Hale, Feb. 7, 1862, NARG 45, entry 5, vol. 11. The assertion that attacks on Confederate seaports were motivated by the need to vindicate the monitors is incorrect; Welles set out the Navy's offensive plans before any monitors were completed.

23. Ericsson, "Building of the Monitor," 732; Ericsson to Fox, Apr. 10, 1863, Ericsson Papers, reel 3; Church, *Life of John Ericsson,* 2: 55. Eleven-inch shot weighed 187 pounds; 15-inch shot weighed 400 pounds. Navy Department, Bureau of Ordnance, *Ordnance Instructions for the United States Navy* (Washington: GPO, 1866), 3: xiv–xv; NARG 45, subject file AD, box 51, Stimers to Joseph Smith, Feb. 6, 1862 (typescript marked "NWR 2602:59").

24. Church, *Life of John Ericsson,* 2: 4. Fox to J. Hayden, Apr. 3, 1862, *Correspondence of Fox,* 2: 285. Contracts for six Ericsson-built vessels were signed on March 31, 1862; NARG 19, entry 235, Contracts for Construction of Naval Vessels 1861–1865, s.v. "*Passaic*"; a preprinted contract is in NARG 45, subject file AC—Construction, box 22.

25. Percival Drayton to Du Pont, Nov. 24, 1862, *Du Pont Letters,* 2: 293. Drayton

was then the prospective commanding officer of the *Passaic*. Fox asked Ericsson to visit Hampton Roads to inspect the battle-tested *Monitor*, but he declined. Mindell, *War, Technology, and Experience*, 90.

26. Fox to Harrison Loring, Apr. 14, 1862, NARG 45, entry M209, Miscellaneous Letters Sent by the Secretary of the Navy, 68: 63. Ericsson was to receive $4,000 per vessel for the plans, which he furnished direct to the builders. Nelson Curtis to Welles, May 11, 1862, NARG 45, entry M124, roll 407, 8; Deposition of Alban C. Stimers, Aug. 25, 1873, NARG 123, entry 1, case 7157, Miles Greenwood vs. United States.

27. Technical centralization to promote efficiency and rapid construction was not confined to the monitors. Isherwood ordered engines that duplicated earlier machinery, stressing the need for specifications in which, "There is not a bolt, a nut, or a screw left out." *Charges Against the Navy Department,* House Miscellaneous Document (HMiscDoc) 201, 42d Cong., 2d sess., 295–96. Ericsson to Welles, Feb. 5, 1863, NARG 45, entry M124, roll 433, 67.

28. Church, *Life of John Ericsson*, 2: 5; Harrison Loring to Welles, Feb. 10, 1862, NARG 45, entry M124, roll 398, 171. By mid March, the group had obtained all the iron needed for turret and side armor for six vessels. John A. Griswold to Welles, Mar. 19, 1862, ibid., roll 401, 253.

29. Church, *Life of John Ericsson*, 2: 5. At that time, interchangeability was not common; it was generally achieved by using a complicated and expensive system of fixtures and inspection gauges. David A. Hounshell, *From the American System to Mass Production 1800–1932: The Development of Manufacturing Technology in the United States* (Baltimore: Johns Hopkins University Press, 1984), 27, 41–46.

30. Fox to Charles A. Secor, Apr. 14, 1862, NARG 45, entry M209, 68: 67; Fox to Harrison Loring, Apr. 17, 1862, ibid., 82.

31. Harrison Loring to Fox, Apr. 17, 1862, NARG 45, entry M124, roll 404, 174; Loring to Fox, Apr. 18, 1862, ibid., 206; Fox to Loring, Apr. 18, 1862, NARG 45, entry M209, 68: 86. Loring to Welles, Apr. 22, 1862, NARG 45, entry M124, roll 405, 52; Fox to Loring, Apr. 23, 1862, NARG 45, entry M209, 68: 113; Loring to Fox, NARG 45, entry M124, roll 405, 103.

32. Curtis to Fox, May 2, 1862, NARG 45, entry M124, roll 406, 7; Curtis to Welles, May 11, 1862, ibid., roll 407, 8; Loring to Welles, May 5, 1862, ibid, roll 406, 111. The tenth vessel was the *Camanche*, built by Donohue, Ryan & Secor for West Coast service. The Secors actually built the ship; Peter Donohue owned an ironworks in California, while J. T. Ryan "is not supposed to have much means, but knows how to engineer a Contract thro[ugh] Congress" (R. G. Dun, New

York, 380: 8). References herein to the Passaic class apply to the nine East Coast ships.

33. Rowland did the ironwork by the pound and the woodwork at a lump sum for the vessel. NARG 19, entry 186, Papers Relating to Claims in Connection with the Construction of Civil War Vessels, 1862–1865, s.v. "*Passaic*."

34. U.S. Census Office, *Manufactures of the United States in 1860, Compiled from the Original Returns of the Eighth Census* (Washington, D.C.: GPO, 1865), 522–27. Heinrich gives figures for 1850 as $12,600 and twenty-nine workers, which implies that wooden shipbuilding had become slightly more capital-intensive during the decade before the war. Thomas R. Heinrich, *Ships for the Seven Seas: Philadelphia Shipbuilding in the Age of Industrial Capitalism* (Baltimore: Johns Hopkins University Press, 1997), 19, 21. Figures for 1880 from George Michael O'Har, "Shipbuilding, Markets, and Technological Change in East Boston" (Ph.D. thesis, Massachusetts Institute of Technology, 1994), 158–59.

35. O'Har, "Shipbuilding, Markets and Technological Change," 160.

36. Stimers to Fox, Apr. 8, 1864, Fox Papers, box 9. John G. B. Hutchins, *The American Maritime Industries and Public Policy, 1789–1914: An Economic History* (New York: Russell & Russell, 1941), 449, considers only ships registered in the United States, shown in *Annual Report of the Commissioner of Navigation,* House Executive Document (HExcDoc) 14, 56th Cong., 1st sess., app. L, 217–22. Harlan & Hollingsworth Co., *1836 Semi-Centennial Memoir of the Harlan & Hollingsworth Company, Wilmington, Delaware, USA* (Wilmington, Del.: Harlan & Hollingsworth, 1886), 249–63; 376–89. Gross tonnage is a measure of volume, related only loosely to displacement. Legal complexities aside, one gross ton equals 100 cubic feet of enclosed volume.

37. In 1856, the firm was reportedly worth $100,000; in late 1864, $500,000; in 1866, between $500,000 and $1 million. R. G. Dun, Delaware, 2: 38.

38. HExcDoc 14, 56th Cong., 1st sess., app. L, 218; Heinrich, *Ships for the Seven Seas,* 20–21. R. G. Dun, Pennsylvania, 57: 374. NARG 41, Records of the Bureau of Marine Inspection and Navigation, entry 138, Record of Metal Vessels Built, 1825–1919.

39. R. G. Dun, New York, 378: 458; NARG 41, entry 138.

40. Rowland agreed to install the lids for 10¢ a pound. The midships ports cost him almost 50¢ a pound and those at the stern nearly $1 a pound for labor to install, exclusive of material. Rowland to Wm. E. Everett, 15 May 1862, NARG 19, entry 71, 2: 172.

41. HExcDoc 14, 56th Cong., 1st sess., app. L, 217–18. Robert B. Forbes, *Personal Reminiscences* (2d rev. ed., Boston: Little, Brown, 1882), following 412.

42. Affidavit of James F. Secor, May 4, 1898, SRep 1263, 55th Cong., 2d sess., 3; R. G. Dun, New York, 319: 409; 340: 42; 370: 679, 700-A63; 376: 212. Ibid., 317: 210 and 300G; New Jersey, 30: 204. Census of 1860, New York, 3d Dist., 15th Ward, NYC, roll 805: 495–96. Deposition of James F. Secor, Aug. 23, 1909, NARG 123, entry 1, cases 29,939, 29,943, and 29,944, James F. Secor and Anna A. Secor, Executors of the Will of James F. Secor, Deceased, Survivor of Zeno Secor and Charles A. Secor, v. United States, (hereafter "Secor Cases"). Evidence in the three cases was commingled.

43. Stimers testimony, Light Draught Monitors, 92. It is unclear whether by 1865 Stimers had learned of the opinion Ericsson expressed of his design in late April 1862.

44. Welles to Hale and Sedgwick, Mar. 25, 1862, NARG 45, entry 5, vol. 11. Fox to J. Hayden, Apr. 3, 1862, *Correspondence of Fox,* 2: 286.

45. Welles to Ericsson, May 23, 1862, NARG 45, entry M209, 68: 273, asks for more information. Welles to Ericsson, June 23, 1862, Welles Papers, reel 5, container 7, letterbook, June 21–Oct. 4, 1862, 107; Ericsson to Welles, July 2, 1862, NARG 45, entry M124, roll 412, 36.

46. Isherwood testimony, Light Draught Monitors, 116. Welles to Thomas J. Griffin, Apr. 18, 1863, NARG 45, entry M209, 68: 57, 208. Stimers to Gregory, Sept. 28, 1863, NARG 19, entry 64, Letters Received from Superintendents Outside of Navy Yards.

47. Reports of local inspectors are in NARG 19, entries 64 and 68, Reports Received from Superintendents Outside of Navy Yards; reports of local inspectors of machinery in NARG 19, entries 974 and 975, Reports of Inspectors of Machinery for Ironclad Steamers. Most reports were biweekly.

48. I am indebted to Dr. Kurt H. Hackemer for this insight. Some builders tried to stack the deck; Harrison Loring demanded a "middle aged sensible practicable man" as inspector. Harrison Loring to Fox, Apr. 17, 1862, NARG 45, entry M124, roll 404, 174.

49. Fox mentioned both as early as June 3, 1862, when he wrote Du Pont to "give us Charleston if possible. . . . We should be inclined to skip Fort Caswell [at Wilmington] if you consider it imperative, for the Fall of Charleston is the fall of Satan's Kingdom." Fox to Du Pont, June 3, 1862, *Correspondence of Fox,* 1: 128.

50. Report of Commander Rodgers, May 16, 1862, *ORN* 7: 357. The damage would keep the *Galena* from attacking Fort Caswell. Goldsborough to Fox, June 16, 1862, Fox Papers, box 3.

51. Fox to Du Pont, Aug. 5, 1862, *Correspondence of Fox,* 1: 144.

52. Fox to Ericsson, Aug. 5, 1862, Ericsson Papers, reel 4; Ericsson to Fox, Aug. 6, 1862, NARG 45, entry M124, roll 415, 155.

53. Gregory to Lenthall, June 18, 1866, with enclosures, NARG 19, entry 64, 11: 9. Fox to Stimers, Sept. 5, 1862; Fox to Stimers, Sept. 15, 1862; Fox to Stimers, Sept. 25, 1862, all in Fox Papers, box 5. Gregory said he had not known about the overtime pay, but he had endorsed Stimers's report of October 4, 1862. This mention of overtime was a misstep on the part of Stimers. Fox emphasized the nature of their relationship by cautioning him on October 8, 1862: "All my letters to you are unofficial and you must not use them in your official dispatches" (ibid.).

54. Fox to Stimers, Sept. 27, 1862, box 5. Welles to Gregory, Sept. 26, 1862, NARG 19, entry 186, s.v. "*Passaic.*" Stimers to Gregory, Oct. 4, 1862, NARG 19, entry 974, 1: 11.

55. Blank form contract for Passaic class, NARG 45, subject file AC—Construction, box 22.

56. NARG 71, entry 48, Contract Ledger for Iron Clads 1861–62, 1: 11–12. Church, *Life of John Ericsson,* 2: 10; Welles to Ericsson, Apr. 22, 1862, NARG 45, entry M209, 68: 108.

57. Philip Scranton, *Endless Novelty: Specialty Production and American Industrialization, 1865–1925,* (Princeton: Princeton University Press, 1997), 45–46. Cost accounting may have advanced farther than Scranton thinks. The "long practice in machine shops" was to add 25 percent to the actual cost of labor and materials to cover overhead, rents, depreciation, and power. Deposition of Cornelius H. Delamater, July 30, 1877, in Court of Claims 6327, Alexander Swift et al. v. United States, NARG 19, entry 186, s.v. "*Catawba.*"

58. Fox to Dahlgren, Mar. 11, 1862 (telegram), Library of Congress, Papers of John A. Dahlgren, box 5, "General Correspondence 1862" folder.

59. Schneller, *Quest for Glory,* 203–9, 218–23. Fox to Ericsson, Sept. 27, 1862, Ericsson Papers, reel 4.

60. Drayton to Du Pont, Nov. 8, 1862, *Du Pont Letters,* 2: 279–81. Ericsson said enlarging the gunports would weaken the turret; his refusal to back down may reflect the character that Du Pont described as "pigheaded but honest." Du Pont to Sophie Du Pont, in journal letter 29, Jan. 16–24, 1863, *Du Pont Letters,* 2: 372; Du Pont to William Whetten, Mar. 17, 1863, ibid., 2: 489–93.

61. Drayton to Du Pont, Nov. 24, 1862, *Du Pont Letters,* 2: 292–93.

62. Ericsson to Fox, 29 Dec. 1862, NARG 45, entry M124, roll 429, 104; Ericsson to Welles, Mar. 29, 1863, ibid., roll 438, 127. Ericsson wrote that Drayton "seems bent on prejudicing everybody against the vessel under his command." Ericsson to Fox, Dec. 30, 1862; Ericsson to Fox, Dec. 21, 1862, both in Fox Papers, box 3.

63. Stimers to Gregory, Nov. 8, 1862, NARG 19, entry 65, 2: 217.

64. The gun muzzle was modified to fit into a "smoke box" attached to the in-

side of the turret (Fig. 2.3). The box had a slot to allow the gun to elevate, with a sliding plate over it to keep smoke and concussion from escaping. Stimers to Gregory, Nov. 15 and 22, 1862, NARG 19, entry 65, 2: 239, 262. Later monitors had larger ports and longer guns, eliminating the need for the smoke box.

Chapter 3. The Navy Looks West

1. Fox to Ericsson, Aug. 5, 1862, Ericsson Papers, reel 4; Chief Engineer William W. W. Wood's testimony, HMiscDoc 201, 42d Cong., 2d sess., 191.

2. Stimers testimony, Light Draught Monitors, 92, 95. Deposition of Alban C. Stimers, Aug. 25, 1873, NARG 123, entry 1, case 7157, Greenwood v. United States; Deposition of Alban C. Stimers, Aug. 11, 18, 19, 1873, ibid., cases 6326/6327, Swift v. United States.

3. Fox to Stimers, Apr. 23, 1862, Fox Papers, box 5; Stimers to Fox, Apr. 24, 1862, ibid., box 4. "Fast" monitors: see, e.g., Fox to Stimers, Sept. 27, 1862, and Oct. 7, 1862, both in ibid., box 5.

4. Stimers wanted to let contracts by invitation, but Fox demurred: "We must advertise by law: there is no help for it, but we can confine the work to bona fide workers." Fox to Stimers, Aug. 13, 1862, Fox Papers, box 5. "Iron Vessels for River and Harbor Defense," Aug. 14, 1862, in NARG 19, entry 405.

5. Deposition of Nathaniel G. Thom, Dec. 29 and 30, 1876, Jan. 2, 1877, July 9 and 10, 1877, NARG 123, entry 1, case 7157, Greenwood v. United States; deposition of Charles A. Secor, Apr. 24, 1876, ibid. J. F. Secor to Welles, Aug. 16, 1862, NARG 45, entry M124, roll 416, 160; deposition of Charles A. Secor, Apr. 24, 1876, NARG 123, entry 1, case 7157, Greenwood v. United States. Deposition of Nathaniel G. Thom, Dec. 29 and 30, 1876, Jan. 2, 1877, July 9 and 10, 1877, ibid.

6. Blank contract for harbor and river monitors, NARG 45, subject file AC—Construction, box 22.

7. Deposition of Nathaniel G. Thom, Dec. 29 and 30, 1876, Jan. 2, 1877, July 9 and 10, 1877, NARG 123, entry 1, case 7157, Greenwood v. United States; deposition of Charles A. Secor, Apr. 24, 1876, ibid.; Claimants' Request for Findings, filed Jan. 28, 1892, ibid., case 16,834, John N. Snowdon v. United States. Thom was told 1,322,905 pounds of iron would be required, less than half the 2,948,000 pounds actually used. Deposition of Nathaniel G. Thom, May 28, 1875, ibid., cases 6326/6327, Swift v. United States. The Navy inspector understood "entirely informal[ly]" that the vessels had been enlarged. Deposition of Charles H. Loring, NARG 123, entry 1, case 7157, Greenwood v. United States.

8. Report of Aaron H. Cragin and Isaac Newton, Special Commissioners Appointed by the Court, NARG 123, entry 1, case 6327, Alexander Swift v. United States; "Report of the Board Consisting of Naval Constructor Philip Hichborn,

USN, and Chief Engineer Harrie Webster, USN," NARG 19, entry 188, Report of a Board of Naval Officers in the Case of the Monitor *Manayunk*, Dec. 12, 1892. Weeks after bidding closed, Stimers told Fox, "I made the change in the specifications" to double the deck armor and "I am having written into them" the lists of equipment to be furnished. Stimers to Fox, Sept. 12, 1862, Fox Papers, box 4.

9. The "harbor and river monitors" are known by various class names, including Canonicus (after the first of the class to be launched), Saugus (after the first to be commissioned), and Tecumseh (after the first to be sunk). Most contemporary documents refer to them as the Tippecanoe class.

10. Abstract of Offers made under Advertisement of Navy Department of Aug. 16 [*sic*], 1862, for Iron Vessels for River and Harbor Defense, NARG 19, entry 186, envelope 620, proposals. Fox to Ericsson, Aug. 5, 1862, Ericsson Papers, reel 4.

11. "The Memorial of the Chamber of Commerce. . . ." *Cincinnati Daily Commercial*, Jan. 9, 1862, 2. Greenwood to Chase, Oct. 25, 1861, Salmon P. Chase Papers, Microfilm Edition (Frederick, Md.: University Publications of America, 1987), reel 17, frames 0885–0887.

12. "Removal of Government Work from Cincinnati." *Cincinnati Daily Commercial*, Jan. 20, 1862, 2. Chase advised on Jan. 22, 1862, that he had presented Cincinnati's claims and would continue to do so. *The Salmon P. Chase Papers*, ed. John Niven, vol. 1: *Journals, 1829–1872* (Kent, Ohio: Kent State University Press, 1993), 328.

13. Heather Cox Richardson, *The Greatest Nation of the Earth: Republican Economic Policies During the Civil War* (Cambridge, Mass.: Harvard University Press, 1997), 13–15.

14. R. G. Dun, Pennsylvania, 66: 576B; Ohio 79: 271. Surdam, "Northern Naval Superiority," 202–13.

15. Charles R. Wilson, "Cincinnati a Southern Outpost in 1860–1861?" *Mississippi Valley Historical Review* 24, no. 4 (Mar. 1938): 473–82; William G. Carleton, "Civil War Dissidence in the North: The Perspective of a Century," *South Atlantic Quarterly* 65, no. 3 (Summer 1966): 390–402.

16. Many published items asserted the danger of a "Northwest Confederation"; e.g., *Cincinnati Daily Commercial* July 21, 1862, 2; Dec. 30, 1862, 2; Jan. 14, 1863, 2; Mar. 12, 1863, 2. Steven Z. Starr, "Was There a Northwest Conspiracy?" *Filson Club History Quarterly* 38, no. 4 (Oct. 1964): 323–41.

17. Fox to J. G. Barnard, July 23, 1862, *Correspondence of Fox*, 2: 329; Fox to Du Pont, ibid., 1: 144; Fox to George D. Morgan, Dec. 18, 1862, ibid., 2: 471; Holbrook Fitz John Porter, "The Delamater Iron Works—The Cradle of the Modern Navy," *Transactions of the Society of Naval Architects and Marine Engineers* 26 (1918): 12–13; Robert J. Browning Jr., *Cape Charles to Cape Fear: The North At-*

lantic Blockading Squadron in the Civil War (Tuscaloosa: University of Alabama Press, 1993), 150–57. William H. Webb to Joseph Smith, Aug. 7, 1862, NARG 71, entry 5, Miscellaneous Letters Received, June 2–Nov. 27, 1862, 106.

18. Canney, *Ironclads,* 35–45, for conversions; 47–55, 95–118 for purpose-built vessels. James M. Merrill, "Union Shipbuilding on Western Rivers During the Civil War," *Smithsonian Journal of History* 3 (Winter 1968–69): 17–44.

19. Charles Cist, *Sketches and Statistics of Cincinnati in 1859,* (Cincinnati: n.p., 1859), 332. U.S. Census Office, *Manufactures of the United States in 1860,* 453–56. Neither Kenton County (Covington) nor Campbell County (Newport), Kentucky, reported any ship- or boatbuilding firms in 1860. (The decline in Cincinnati shipbuilding might be more apparent than real if shipyards overstated their employment and revenues to Cist's "booster" publication and understated them to official inquirers.)

20. U.S. Census Office, *Manufactures of the United States in 1860,* 453–56, 171. Scranton, *Endless Novelty,* 18–19. Such an industrial district was vital to the growth of the Baldwin Locomotive Works in the 1860s. John K. Brown, *The Baldwin Locomotive Works, 1831–1915: A Study in American Industrial Practice* (Baltimore: Johns Hopkins University Press, 1995), 37–38.

21. Merrill, "Union Shipbuilding," 19–20; John D. Milligan, "From Theory to Application: The Emergence of the American Ironclad War Vessel," *Military Affairs* 48, no. 3 (July 1984), 126–32.

22. "Annual Statement of the Commerce of Cincinnati for the Commercial Year Ending Aug. 31, '62," *Cincinnati Daily Commercial,* 2. A maze of subcontracts makes it difficult to trace the vessels.

23. Fox to Andrew Hull Foote, Mar. 7, 1862, *Correspondence of Fox,* 2: 42. Welles to Nathaniel G. Thom [Greenwood's superintendent—Welles referred him to Foote], Sept. 21, 1861, NARG 45, entry M209, 65: 451.Welles to Alexander Swift & Co., June 11, 1862, ibid., 68: 376. Swift & Co. to Welles, June 7, 1862, ibid., entry M124, roll 409, 141.

24. Western Biographical Publishing Company, *The Biographical Cyclopaedia and Portrait Gallery with an Historical Sketch of the State of Ohio* (Cincinnati: Western Biographical Publishing Company, 1884), 2: 469–70; Cist, *Sketches and Statistics,* 278–79.

25. Definitions: Scranton, *Endless Novelty,* 10. Shipbuilders were specialty producers, whose key elements were "flexible technology, skilled labor, and rapid response to markets." Heinrich, *Ships for the Seven Seas,* 3–4, 86. Descriptions of Greenwood's business stress items that would fall into the batch or bulk categories.

26. "Obituary: Alexander Swift, the Veteran Citizen, Passes Away Quietly,"

Cincinnati Commercial Gazette, May 24, 1891, 5; R. G. Dun, Ohio, 79: 268; Kentucky, 6: 175; Ohio, 82: 71. For Ricker, ibid., Ohio, 78: 167; 79: 81. For Westwood, ibid., Ohio, 81: 63.

27. R. G. Dun, Ohio, 79: 271.

28. Cist, *Sketches and Statistics,* 288–89. R. G. Dun, Ohio, 79: 271.

29. Swift & Co. to Welles, June 7, 1862, NARG 45, entry M124, roll 409, 141. Alexander Swift & Co. to Welles, July 11, 1862, ibid., roll 413, 1; Welles to Alexander Swift, July 17, 1862, NARG 45, entry M209, 69: 5.

30. "Iron Vessels for River and Harbor Defence," *Cincinnati Daily Commercial,* Aug. 15, 1862, 3. Like Swift, Greenwood probably knew about the ships in advance. His superintendent, Thom, went to New York to discuss shipbuilding tools and methods before the Navy advertised for the ships. Deposition of Nathaniel G. Thom, Dec. 29–30, 1876, Jan. 2, 1877, July 9–10, 1877, NARG 123, entry 1, case 7157, Greenwood v. United States.

31. NARG 19, entry 186, envelope 620, Offers . . . for Iron Vessels. Neither Swift nor Greenwood seems to have approached Ohio politicians.

32. Naval History Division, *Monitors,* 20–23. Perine's ship was built by the corporate entity of Perine, Secor & Co., from which Perine withdrew the day the contract was signed. Brief in Support of the Motions to Dismiss, NARG 123, entry 1, case 29,939, Secor Cases, 2.

33. Blank contract for harbor and river monitors, NARG 45, subject file AC—Construction; petition filed Oct. 21, 1890, NARG 123, entry 1, case 16,834, Snowdon v. United States. The penalty on the monitors was 0.11 percent per day; on the gunboats, only 0.067 percent per day. The monitor reservation was 25 percent; the gunboat reservation 20 percent. U.S. Congress, *Certain War Vessels Built in 1862–1865,* Senate Report (SRep) 1942, 57th Cong., 1st sess., 20–22. Hackemer discusses the monitor contracts in *The U.S. Navy and the Origins of the Military-Industrial Complex,* 112–14.

34. Deposition of Theodore Allen, July 25, 1877, NARG 123, entry 1, cases 6326/6327, Swift v. United States.

35. E.g., Harlan & Hollingsworth to Fox, Oct. 4, 1862, NARG 45, entry M124, roll 421, 105.

36. Deposition of Alexander Swift, Nov. 10–11, 1876, NARG 123, entry 1, case 7157, Greenwood v. United States; deposition of Nathaniel G. Thom, Dec. 29–30, 1876, Jan. 2, 1877, July 9–10, 1877, ibid.

37. Deposition of Isaac Winn, Oct. 5, 1891, NARG 123, entry 1, case 16,834, Snowdon v. United States.

38. Deposition of Nathaniel G. Thom, Dec. 29–30, 1876, Jan. 2, 1877, July 9–10, 1877, NARG 123, entry 1, case 7157, Greenwood v. United States, in which ex-

cerpts from Thom's diary give a day-by-day picture of the enterprise. Deposition of Henry E. Nottingham, Aug. 25, 1877, ibid. Possessive use of a principal's name (e.g., "Greenwood's") refers to the firm, since it is almost impossible to ascertain whether a firm's principal(s) acted personally in any given case.

39. Deposition of Nathaniel G. Thom, May 28, 1875, NARG 123, entry 1, cases 6326/6327, Swift v. United States. This meant fabricating material, since Greenwood laid the ship's keel on November 5, 1862. Brief for Defendants filed Dec. 16, 1878, ibid., case 7157, Greenwood v. United States, 23.

40. Deposition of Alexander Swift, Nov. 10–11, 1876, NARG 123, entry 1, case 7157, Greenwood v. United States. Swift's testimony was not disinterested, since readiness to begin was a key element in his own claim against the government. Deposition of Nathaniel G. Thom, Apr. 25, 1876, ibid., cases 6326/6327, Swift v. United States.

41. The Snowdons lost heavily when Southern accounts went unpaid in 1861. By 1863, they were worthy of "cr[edit] with caution" due to their "Govt contract for building a Gun Boat which when completed will amount to 1/2 million." R. G. Dun, Pennsylvania, 66: 576B; 7: 199. Deposition of John N. Snowdon, Oct. 5, 1891, NARG 123, entry 1, case 16834, Snowdon v. United States; defendants' brief filed Feb. 21, 1893, ibid., 19.

42. Although Mason was "a g[oo]d boat builder of excell[en]t standing & char[acter]," his capital was clearly inadequate for a $500,000 venture. R. G. Dun, Pennsylvania, 66: 47m; 7: 199.

43. Deposition of John N. Snowdon, Oct. 5, 1891, NARG 123, entry 1, case 16,834, Snowdon v. United States; Deposition of Jacob Graser, Oct. 5, 1891, ibid.; Claimant's Motion for Additional Findings, no date, ibid.

44. Heinrich, *Ships for the Seven Seas,* 52. John N. Ingham, *Making Iron and Steel: Independent Mills in Pittsburgh, 1820–1920* (Columbus: Ohio State University Press, 1991), 21–46; William F. Trimble, "From Sail to Steam: Shipbuilding in the Pittsburgh Area, 1790–1865," *Western Pennsylvania Historical Magazine* 58, no. 2 (Apr. 1975), 159–64.

45. The "experienced" yards of the East Coast had a head start on the Tippecanoe class, but they had worked out their "teething troubles" on the much-delayed Passaics. In 1863, "the concern [Greenwood] at Cincinnati had equal facilities with those who were newly constructing vessels on the Atlantic seaboard." Deposition of Theodore Allen, Apr. 29, 1874, NARG 123, entry 1, case 7157, Greenwood v. United States.

46. Harrison Loring to Fox, Sept. 11, 1862, NARG 45, entry M124, roll 419, 11. Deposition of Jacob Graser, Oct. 5, 1891, NARG 123, entry 1, case 16,834, Snowdon v. United States. Deposition of Nathaniel G. Thom, Dec. 29–30, 1876, Jan. 2, 1877,

July 9–10, 1877, ibid., case 7157, Greenwood v. United States. Thom spent three weeks in New York but left "without a single official drawing, specification, or any thing by which to start with on our gun boat." Thom to "T. J. Fox" [G. V. Fox], Sept. 22, 1862, endorsed by Fox to Stimers on Sept. 23. NARG 19, entry 186, s.v. "*Mahopac*."

47. Stimers to Gregory, Sept. 13, 1862, NARG 19, entry 65, box 1, 2: 20.

48. NARG 19, entry 1259, Record of Monitor Drawings Sent to Contractors.

49. Deposition of Alban C. Stimers, Aug. 25, 1873, NARG 123, entry 1, case 7157, Greenwood v. United States. The contractors pressed for a longer extension. Stimers to Fox, Nov. 20, 1862, Fox Papers, box 4.

50. "Swift and the Niles Works' Case," 14 CtClms 235, 242–44, lists the plans in order of the dates they were furnished to the contractors, and Thom's diary-enhanced recollection confirms the sequence. Deposition of Nathaniel G. Thom, Dec. 29–30 1876, Jan. 2, 1877, July 9–10, 1877, NARG 123, entry 1, case 7157, Greenwood v. United States.

51. Deposition of Alban C. Stimers, Aug. 11, 18, 19, 1873, NARG 123, entry 1, cases 6326/6327, Swift v. United States; also deposition of Theodore Allen, Apr. 29, 1874, ibid., case 7157, Greenwood v. United States: "the contractors knew nothing about such vessels" so "every bolt and rivet had to be shown in the greatest detail." Deposition of Nathaniel G. Thom, May 28, 1875, NARG 123, entry 1, cases 6326/6327, Swift v. United States; deposition of Joseph S. Kirk, May 30, 1876, ibid.

52. Deviation from Ericsson's drawings in the monitors *Passaic*, *Montauk*, and *Kaatskill* (*Catskill*) resulted in leakage between the after overhang and the hull. Ericsson to Fox, Jan. 10, 1863, NARG 45, entry M124, roll 430, 168. This discovery must have reinforced the Navy's determination to enforce strict compliance with centrally issued drawings.

53. Deposition of Alban C. Stimers, Aug. 25, 1873, NARG 123, entry 1, case 7157, Greenwood v. United States; deposition of Nathaniel G. Thom, Dec. 29–30, 1876, Jan. 2, 1877, July 9–10, 1877, ibid. Stimers to Fox, Sept. 6, 1862, Fox Papers, box 4.

54. "In consideration of the light draft boats we shall not give out any more Monitors." Fox to Stimers, Sept. 15, 1862 (unofficial), Fox Papers, box 5. If we "employ the force remaining to us in the country upon the six foot boats it would be better than giving out any more of the *Tippecanoe* class. They can be completed sooner." Stimers to Fox, Oct. 8, 1862, ibid., box 4.

55. Fox to Ericsson, Aug. 8, 1862 (typescript), Fox Papers, box 3. Stimers to Fox, Sept. 17, 1862, ibid., box 4. Stimers to Fox, Sept. 22, 1862 (typescript marked "NWR 305:10"), NARG 45, subject file AC. Stimers to Fox, Oct. 9, 1862, ibid.

56. Stimers to Fox, Sept. 12, 1862, Fox Papers, box 4.

57. Stimers to Fox, Oct. 8, 1862, Fox Papers, box 4. Fox to Niles Works, Harrison Loring, Harlan & Hollingsworth, Oct. 1, 1862, NARG 45, entry M209, 69: 41. Niles Works to Fox, Oct. 2, 1862, NARG 45, entry M124, roll 421, 29. Harlan & Hollingsworth to Fox, Oct. 4, 1862, ibid., roll 421, 105; Harlan & Hollingsworth to Fox, Oct. 11, 1862, ibid., roll 422, 16.

58. Harrison Loring to Fox, Oct. 3, 1862, ibid., entry M124, roll 421, 60; Fox to Loring, Oct. 4, 1862, ibid., M209, 69: 417. Fox to Stimers, Oct. 7, 1862, Fox Papers, box 5. Fox wanted Loring because "we did not wish to have a party capable of doing the work, say that they were willing to undertake one and the Government refused" (ibid.).

59. Welles to Captain Joseph Hull, Sept. 26, 1862, *ORN* 23: 381. (The *Oneota* was under Gregory from her inception.) "This gives us one organization." Fox to Stimers, Sept. 20, 1862 (unofficial), Fox Papers, box 5. Stimers to Fox, Sept. 22, 1862 (typescript marked "NWR 305:10"), NARG 45, subject file AC; Fox to Stimers, Sept. 25, 1862 (unofficial), Fox Papers, box 5.

Chapter 4. Mobilization on the Ohio River

1. John W. Watson, "The Building of the Ship," *Harper's New Monthly Magazine* 24, no. 143 (Apr. 1862): 609. E[dward] J. Reed, *Shipbuilding in Iron and Steel: A Practical Treatise* (London: John Murray, 1869), 428–63; Heinrich, *Ships for the Seven Seas,* 87–92.

2. Ericsson to Lenthall, Feb. 17, 1864, Fox Papers, box 8; deposition of Nathaniel G. Thom, Dec. 29–30, 1876, Jan. 2, 1877, July 9–10, 1877, NARG 123, entry 1, case 7157, Greenwood v. United States. Deposition of Joseph S. Kirk, May 30, 1876, ibid., cases 6326/6327, Swift v. United States.

3. Supplemental argument of defendants, filed Mar. 17, 1875, NARG 123, entry 1, case 7157, Greenwood v. United States; brief for defendants, filed Dec. 16, 1878, ibid., 23. Copy of report of inspector Charles H. Loring [for the *Catawba* and *Oneota*], Nov. 11, 1862, NARG 123, entry 1, cases 6326/6327, Swift v. United States.

4. Deposition of Nathaniel G. Thom, Dec. 29–30, 1876, Jan. 2, 1877, July 9–10, 1877, NARG 123, entry 1, case 7157, Greenwood v. United States. The ready availability of such tools evinces Cincinnati's strength as an industrial center.

5. This definition leaves gray areas. A manufacturer who builds a pump is a supplier. If the manufacturer sends a representative to supervise its installation, he is still a supplier; if he sends a work crew to install the pump, he may be a subcontractor. In 1860s usage, a firm might "subcontract" another firm to make and furnish a valve or a forging; in modern parlance the second firm is a supplier.

6. Heinrich, *Ships for the Seven Seas,* 22–23, 62–63.

7. Deposition of Gustavus Ricker, Jan. 5, 1877, NARG 123, entry 1, cases 6326/6327, Swift v. United States. (The more Ricker was questioned, the more complex the relationships appear.) Deposition of Edward A. Jenks, June 15, 1875, ibid. Some "subcontractors" probably were "inside contractors," employees who contracted with their employer to produce an item. Employers provided tools and materials but the inside contractor furnished labor and supervision, hoping to make a profit. Brown, *Baldwin Locomotive Works,* 115–16; Hounshell, *From the American System to Mass Production,* 50, 111.

8. This was perhaps because Litherbury's business acumen was questionable; years later a contemporary observed that Litherbury, "wouldn't do to offer as a good example any way for he is busted wide open. . . . he won't do to tie to" (deposition of Oliver Perry Clark, July 25, 1877, NARG 123, entry 1, cases 6326/6327, Swift v. United States). In 1862, Litherbury lost "considerable money by steamboats." (R. G. Dun, Ohio, 81: 252).

9. Thom's daily route took him past the Niles Works and the Swift/Niles shipyard, so his diary and depositions provide glimpses of the *Catawba* and *Oneota* under construction.

10. Deposition of Nathaniel G. Thom, Dec. 29–30, 1876, Jan. 2, 1877, July 9–10, 1877, NARG 123, entry 1, case 7157, Greenwood v. United States; deposition of Richard Tudor, July 14 and 20, 1877, ibid. deposition of Jacob Graser, Oct. 5, 1891, ibid., case 16,834, Snowdon v. United States. Tudor and Grey appear to have been inside contractors.

11. Deposition of Nathaniel G. Thom, Dec. 29–30, 1876; Jan. 2, 1877; July 9–10, 1877, NARG 123, entry 1, case 7157, Greenwood v. United States; N. G. Thom's record of Prices paid by M. Greenwood, exhibit R-RNB, ibid., cases 6326/6327, Swift v. United States. Phillips & Son insisted upon an increase to 5 5/8¢ a pound. Brief for defendants filed Dec. 16, 1878, ibid., case 7157, Greenwood v. United States, 35–36, 38.

12. NARG 24, entry 181, s.v. "*Merrimack.*" Stimers to Fox, Oct. 9, 1862 (second of two), Fox Papers, box 4; Stimers to Charles Loring, May 30, 1863, NARG 19, entry 1252, Letters sent to Contractors and Local Inspectors concerning Harbor and River Monitors, May 1863–Feb. 1864, 1: 129. Loring became engineer in chief in 1884 and retired in 1890.

13. Chief Engineer J. W. King to Welles via Gregory, Apr. 20, 1865, NARG 19, entry 186, s.v. "*Catawba.*"

14. Charles Loring to Stimers, Nov. 11, 1862, NARG 19, entry 64, box 1 (Jan. 1862–June 1863), 2: 2, 3, 4.

15. Stimers to Gregory, Nov. 20, 1862, NARG 19, entry 64, box 1 (Jan. 1862–June 1863), 2: 1. Deposition of Charles H. Loring, Mar. 22 and 25, 1876, NARG 123, entry 1, cases 6326/6327, Swift v. United States.

16. Charles Loring to Stimers, Nov. 25, 1862, NARG 19, entry 64, box 1 (Jan. 1862–June 1863), 2: 41 (*Catawba*), 43 (*Oneota*), (45) (*Tippecanoe*). Greenwood's heavy forging was done outside the shipyard, and the smiths were not included in the manpower numbers Loring forwarded to Stimers. Deposition of Charles H. Loring, Oct. 12 and 13, 1874, NARG 123, entry 1, case 7157, Greenwood v. United States.

17. John Faron to Stimers, Dec. 4, 1862, NARG 19, entry 186, s.v. "*Weehawken.*" Faron to Stimers, Oct. 16 and 20, Nov. 13, 1862, ibid., s.vv. "*Mahopac,*" "*Manhattan,*" and "*Tecumseh.*"

18. Stimers to Fox, Nov. 10, 1862, Fox Papers, box 4.

19. Ibid. Nov. "Greenwood and Secor," Fox to Stimers, Nov. 12, 1862, Fox Papers, box 5; Stimers to Fox, Nov. 14, 1862, ibid., box 4. (The typescript in the Fox Papers incorrectly transcribes "Greenwood" as "Isherwood.") Unfortunately, Stimers did not reveal the plan, and events show that if he had one, he never put it into effect.

20. "Swift and the Niles Works," 14 CtClms 235, 242–44.

21. NARG 45, entry M518, Lenthall, Isherwood, Hartt, and Martin to Welles, May 10, 1862.

22. Rowland, a member of Ericsson's group, "entirely deviated from my plans of the overhang," resulting in gross leakage at sea. Ericsson to Fox, Jan. 8, 1863, NARG 45, entry M124, roll 430, 143; Ericsson to Fox, Dec. 17, 1862, Fox Papers, box 3.

23. Stimers to Fox, Feb. 3, 1862, Fox Papers, box 4.

24. Deposition of Theodore Allen, Apr. 29, 1874. NARG 123, entry 1, 7157, Greenwood v. United States. The advantages of drafting for mechanisms such as marine engines that "posed novel challenges in their complexity, precision, or scale" are noted by John K. Brown, "Design Plans, Working Drawings, National Styles: Engineering Practice in Great Britain and the United States, 1775–1945," *Technology and Culture* 41, no. 2 (Apr. 2000), 208.

25. Deposition of Alban C. Stimers, Aug. 25, 1873, NARG 123, entry 1, case 7157, Greenwood v. United States. "Unmeasured" drawings are "created in the absence of the constraints of nature or physics"; once built, the constraints are reintroduced. Building from unmeasured drawings "entails high risks of expense, physical failure, and failure in use." David Brian McGee, "Floating Bodies, Naval Science: Science, Design and the *Captain* controversy, 1860–1870" (Ph.D. thesis, University of Toronto, 1994), 24–25.

26. Deposition of Charles A. Secor, Apr. 24, 1876, NARG 123, entry 1, case 7157,

Greenwood v. United States; deposition of Alban C. Stimers, Aug. 25, 1873, ibid. Deposition of Nathaniel G. Thom, Dec. 29–30, 1876; Jan. 2, 1877; July 9–10, 1877, ibid. Years later, James F. Secor placed it at "the last of October, 1862." Deposition of James F. Secor, May 4, 1898, in SRep 1263, 55th Cong., 2d sess., 3.

27. Allen made the calculations months after the contracts were let. Deposition of Theodore Allen, Aug. 11, 1873, NARG 123, entry 1, cases 6326/6327, Swift v. United States.

28. Stimers to Fox, Dec. 15, 1862, Fox Papers, box 4; Fox to Stimers, Dec. 18, 1862 (unofficial), ibid., box 5.

29. Stimers to Fox, Dec. 21, 1862, Fox Papers, box 4.

30. Stimers to Secor & Co., Dec. 22, 1862, printed copy in "Petition and Statement of Secor & Co., and Perine Secor & Co." (New York: City Law and Job Printing Office, n.d. [after May 28, 1874]), in NARG 19, entry 186, s.v. "*Mahopac*."

31. This was usually the result of face-to-face interaction between Ericsson and Stimers and of exchanges of letters between Fox and Stimers and Fox and Ericsson. In its purest form: "Enclosed I send you the letter of recommendation which Mr Lenthall can convert into an order and which covers the ground agreed upon at Capt. Ericsson's last night." Stimers to Fox, May 20, 1863, Fox Papers, box 7.

32. "You better send us a copy of the specifications etc. but you must furnish them to contractors. . . . Of course Mr. Lenthall will make the contracts for the boats." Fox to Stimers, Sept. 15, 1862 (unofficial), Fox Papers, box 5. "To get the thing into official routine, the proper bureau would issue a written order to Admiral Gregory, who endorsed it over to me, and that made everything square." Deposition of Alban C. Stimers, Aug. 11, 18, and 19, 1873, NARG 123, entry 1, cases 6326/6327, Swift v. United States.

33. Fox to Stimers, June 4, 1862, Fox Papers, box 5. Isherwood's concerns proved to be well-founded.

34. Lenthall to Stimers, Nov. 21, 1862, Fox Papers, box 4; Stimers to Fox, Nov. 24, 1862, ibid. Stimers makes Lenthall's lack of influence crystal clear: "The idea of permitting a Chief of Bureau to reprimand me by implication for having recommended a change in the specifications of a vessel over which he is exercising really no supervision and the plans of which he does not see is absurd."

35. For *Dunderberg,* see Gregory to Lenthall, Oct. 31, 1862, NARG 19, entry 64, box 1, 1: 171. The divestment of this non-monitor ironclad emphasizes the evolution of the office into an organization concentrating on monitors.

36. President Lincoln, quoted in Hayes, "Captain Fox," 65–67; O. G. Halsted to Fox, Nov. 23, 1862, private and confidential, Fox Papers, box 3. Gregory to Fox, May 25, 1863, Fox Papers, box 6.

37. Hughes, *Rescuing Prometheus,* 89, 103–4; Harvey M. Sapolsky, *The Polaris System Development: Bureaucratic and Programmatic Success in Government* (Cambridge, Mass.: Harvard University Press, 1972), 14, 16, 62–66.

38. Welles, *Diary,* entry for July 19, 1864, 2: 81–82. Welles assessed Fox as a loyal subordinate but thought him at times officious; ibid., entry for Aug. 13, 1863, 1: 401.

39. Fox to Ericsson, Dec. 16, 1862 (typescript), Fox Papers, box 3.

40. The Navy again failed to consider the unique problems of western shipbuilding, but fortunately much of the increased height was above water instead of below. If the ships had drawn 18 inches more, they could not have moved downriver with all weights aboard. Deposition of Nathaniel G. Thom, May 28, 1875, NARG 123, entry 1, cases 6326/6327, Swift v. United States. Nothing in their correspondence indicates that this occurred to Stimers or Fox.

41. Deposition of Charles A. Secor, Apr. 24, 1876, NARG 123, entry 1, case 7157, Greenwood v. United States. "Perine, Secor & Co." was a firm of convenience; the actual work of building the *Manhattan* was done by Secor.

42. Deposition of George Birkbeck Jr., Aug. 13, 1873, NARG 123, entry 1, cases 6326/6327, Swift v. United States. The implied discharge of workmen contradicts James F. Secor's melodramatic recollection in 1898 that the Secors "were directed not to discharge their men, but hold them in readiness day and night to go on" (affidavit of James F. Secor, May 4, 1898, SRep 1263, 55th Cong., 2d sess., 4). It is hard to believe that the Secors would have kept 1,500 men idle, even if assured that the Navy would pay, and James Secor's affidavit shows stretched facts or impaired recall in other areas.

43. Deposition of Charles H. Loring, Mar. 22 and 25, 1876, NARG 123, entry 1, cases 6326/6327, Swift v. United States; deposition of Nathaniel G. Thom, May 28, 1875, ibid; deposition of Joseph S. Kirk, May 30, 1876, ibid., case 16,834, Snowdon v. United States.

44. Deposition of Charles A. Secor, Apr. 24, 1876, NARG 123, entry 1, case 7157, Greenwood v. United States. Swift and Greenwood continued work during Nov.. The Cincinnati ships were well behind the eastern vessels and the changes rumored in November would have involved reducing the deck armor, so continuing to work was a reasonable risk. Work slowed drastically after the December 22 letter, partly because of the changes and partly because a stoppage at the rolling mills curtailed the supply of iron. Loring to Stimers, Dec. 23, 1862, NARG 19, entry 974, 1: 164–66; Loring to Stimers, Jan. 6, 1863, ibid., 2: 18–20, Charles Loring to Stimers, Jan. 20, 1863, ibid., 2: 35–37.

45. Deposition of Alban C. Stimers, Aug. 11, 18, and 19, 1873, NARG 123, entry 1, cases 6326/6327, Swift v. United States. A boilermaker recalled, "We stopped for

some time. . . . there was a great deal of material there that had to be returned and changed." Deposition of Richard Tudor, July 14 and 20, 1877, ibid., case 7157, Greenwood v. United States.

46. From Stimers to Messrs. Secor & Co., Dec. 22, 1862, printed copy in Petition and Statement of Secor & Co, NARG 19, entry 186, s.v. "*Mahopac*."

Chapter 5. Miserable Failures: Combat Lessons and Political Engineering

1. Fox to Du Pont, May 12, 1862, *Correspondence of Fox,* 1: 119. Fox to Goldsborough, May 17, 1862, ibid., 1: 269; Goldsborough to Fox, May 21, 1862, ibid., 1: 273.

2. J. G. Barnard to Fox, Mar. 12, 1862, Fox Papers, box 3. Goldsborough to Fox, June 16, 1862, ibid.

3. Welles, *Diary,* entry for May 26, 1863, 1: 314; "Port Royal." *Philadelphia Daily Evening Bulletin,* Nov. 15, 1861: 1. Fox to Du Pont, Apr. 3 and June 3, 1862, *Correspondence of Fox,* 1: 114–15 and 128.

4. Du Pont to Lammot Du Pont, July 1, 1862, *Du Pont Letters* 2: 147. Du Pont to Sophie Du Pont, Oct. 20, 1862, ibid., 2: 250; Du Pont to Sophie Du Pont, in journal letter 1, Oct. 22, 1862, ibid., 2: 258.

5. Stimers to Fox, Nov. 30, 1862, from Baltimore, Fox Papers, box 4; Drayton to Du Pont, Dec. 20, 1862, *Du Pont Letters,* 2: 305. An anonymous article by one of the *Passaic*'s officers detailed the difficulties. "The First Cruise of the 'Monitor' Passaic," *Harper's New Monthly Magazine,* 27, no. 161 (Oct. 1863): 577–79. Welles to Gregory, Dec. 5, 1862, Welles Papers, reel 5, container 7, letterbook Oct. 4 62–Feb. 2 63, 239–41.

6. Du Pont to Welles, Oct. 25, 1862, *Du Pont Letters,* 2: 266. Du Pont to Henry A. Wise, 16 Jan. 1863, ibid., 2: 358.

7. Du Pont to Sophie Du Pont, Jan. 18 and 19, 1863, in journal letter 29, Jan. 16–24, 1863, *Du Pont Letters,* 2: 366, 368. Butler Diary, entry for Jan. 19, 1863. Du Pont to Sophie Du Pont, Jan. 18 and 19, 1863, in journal letter 29, Jan. 16–24, 1863, *Du Pont Letters,* 2: 368.

8. Du Pont to Welles, Jan. 24, 1863, *Du Pont Letters,* 2: 377. Worden to Du Pont, Jan. 27, 1863, *ORN* 13: 544–45. Du Pont to Benjamin Gerhard, Jan. 30, 1863, *Du Pont Letters,* 2: 394.

9. Du Pont to Welles, Jan. 28, 1863, *ORN,* 543–44. Welles to Du Pont, Jan. 31, 1863, ibid., 13: 571.

10. Worden to Du Pont, Jan. 31, 1863, *ORN* 14: 576; Worden to Du Pont, Feb. 2, 1863, ibid., 14: 626–29 and 630–31; Thomas A. Stephens to Worden, Feb. 2, 1863, ibid., 631–32. Confederate reports, ibid., 14: 633–39.

11. Ericsson to Fox, Oct. 24, 1862, Ericsson Papers, reel 3. Stimers to Fox, Nov. 26, 1862, Fox Papers, box 4; Gregory to Chief Engineer E. D. Robie, Jan. 20, 1863, *ORN* 13: 519–20; Gregory to Du Pont, Jan. 27, 1863, ibid., 537. The *Ericsson* lost three of the rafts en route, and Du Pont told his wife, "It is a pity the fourth did not follow." Du Pont to Welles, Feb. 18, 1863, with enclosures, ibid., 13: 669–70; Du Pont to Sophie Du Pont, Feb. 17, 1863, in journal letter 35, Feb. 15–19, 1863, *Du Pont Letters,* 2: 439.

12. *ORN* 13: 577–624. Du Pont to Turner, Jan. 31, 1863, *Du Pont Letters,* 2: 399; Du Pont to Sophie Du Pont, Feb. 1, 1863, in journal letter 32 (Feb. 1–3, 1863), ibid., 2: 405.

13. The *Monitor* sank on December 31, 1862. Rodgers's report was reprinted in *Report . . . Armored Vessels,* 42–45, with a letter from Rodgers to Ericsson, ibid., 45–46. Ericsson blamed the *Weehawken*'s leakage problems on improper operation, just as he had blamed the operators when the *Monitor* failed to destroy the *Virginia*—to Ericsson, at least, Ericsson's designs could never be at fault. Ericsson to Welles, Jan. 24, 1863, NARG 45, entry M124, roll 432, 71.

14. Du Pont to Welles, Feb. 9, 1863, with enclosures, *ORN* 13: 652–54. Again, Ericsson blamed others: "I claim unhesitatingly that the plan is practically perfect." Ericsson to Welles, Feb. 13, 1863, NARG 45, entry M124, roll 434, 55. Ericsson to Fox, Feb. 19, 1863, ibid., roll 434, 51. A blockader with a similar casualty was towed north for repairs. William Reynolds to Dahlgren, Aug. 21, 1863, NARG 45, entry 395, Letter Books of Officers of the United States Navy at Sea, Mar. 1778–July 1908, subseries E–72, correspondence of CDR William Reynolds, vol. 2.

15. Du Pont to Fox, Nov. 12, 1861, *ORN* 12: 341–42; Du Pont to C. S. Boggs, Feb. 24, 1862, ibid., 12: 561; Du Pont to Sophie Du Pont, in journal letter 47, Mar. 30, 1863, *Du Pont Letters,* 2: 528; Du Pont to Benjamin Gerhard, Feb. 19, 1863, ibid., 2: 446.

16. Welles to Zeno Secor, Feb. 13, 1863, NARG 45, entry M209, 70: 352; Welles to Hiram Paulding, Feb. 13, 1863, *ORN* 13: 662; Welles to Stimers, Feb. 13, 1863, ibid; Ericsson to Fox, Feb. 19, 1863, NARG 45, entry M124, roll 434, 51. This is an early instance of "cannibalization," in which parts are stripped from one ship to repair another. The practice doubles the maintenance burden; besides the work on the receiving ship, the part must be removed from and eventually replaced in the donor ship. (In the 1970s, the official motto of the Polaris submarine program was "Forty-one for freedom"; unofficially, it was "Forty for freedom and one for spares.")

17. John L. Worden to Du Pont, Mar. 3, 1863, with enclosure, Thomas A. Stephens to Worden, *ORN* 13: 700–704. Report of Board of Survey, Stimers, R. W. McCleery, and Faron to Du Pont, Mar. 5, 1863, *ORN* 13: 707–708.

18. Fox to Du Pont, Feb. 20, 1863, *Du Pont Letters,* 2: 450; Du Pont to Fox, Mar. 2, 1863, ibid., 463. Du Pont advised Welles on Feb. 27, *ORN* 13: 692.

19. Reports are in *ORN* 13: 716–34. The Confederates took heart, while Union sailors heard "the Monitors are 'not much account' at Fort McAllister." Butler Diary, entry for Mar. 9, 1863. Stimers to Fox, Feb. 4, 1863, from Philadelphia, Fox Papers, box 7. Stimers to Welles, telegram, Mar. 11, 1863, *ORN* 13: 729. Du Pont to Sophie Du Pont, Mar. 4, 1863, in journal letter 39, Mar. 4–7, 1863, *Du Pont Letters,* 467. "The number of fifteen-inch guns, rather than the number of vessels, will decide your success," Ericsson declared. Fox to Ericsson, Sept. 27, 1862, Ericsson Papers, reel 4; Ericsson to Fox, Sept. 30, 1862, in Church, *Life of John Ericsson,* 2: 45.

20. Ericsson to Welles, Mar. 15, 1863, NARG 45, entry M124, roll 437, 82.

21. Stimers to Fox, Mar. 12, 1863, from Baltimore, Fox Papers, box 7; Fox to Du Pont, Mar. 18, 1863 (unofficial), Fox Papers, box 5A. Seven "bomb decks" were prefabricated but not installed; the materials were eventually used for other purposes at Port Royal.

22. Fox to Du Pont, May 12, 1862, *Correspondence of Fox,* 1: 119 (Fox's emphasis); Fox to Du Pont, June 3, 1862, *Du Pont Letters* 2: 96; Fox to Du Pont, Mar. 11, 1863, ibid., 488. The Confederates feared a joint attack but felt the Union could not spare the troops, so "our greatest danger lies in a naval attack by [the] ironclad fleet." Brigadier General Roswell S. Ripley to Thomas Jordan, Oct. 25, 1862, *OR,* ser. 1, 14: 652–53.

23. Welles to Du Pont, Jan. 6, 1863, *Du Pont Letters,* 2: 352–53; Fox to Du Pont, Feb. 20, 1863 (unofficial), ibid., 450. Du Pont to Sophie Du Pont, June 22, 1862, in journal letter 65, June 19–22, 1862, *Du Pont Letters,* 2: 119–37. Du Pont to Fox, Mar. 2, 1863, ibid., 2: 464 (Du Pont's emphasis).

24. Du Pont to Fox, Aug. 13, 1862, *Correspondence of Fox,* 1: 149. Henry Villard to Murat Halstead, "Private," Feb. 12, 1863, from Hilton Head, S.C., Cincinnati Museum Center, Cincinnati, MS VF 3325. Halstead edited the *Cincinnati Daily Commercial.* Welles, *Diary,* entry for Feb. 16, 1863, 1: 236.

25. Fox to Du Pont, Mar. 11, 1863, *Du Pont Letters,* 2: 487. Welles, *Diary,* entry for Feb. 16, 1863, 1: 236; entry for Mar. 12, 1863, 1: 247.

26. Du Pont to Henry Winter Davis, Apr. 1, 1863, *Du Pont Letters,* 2: 533, and Du Pont to General David Hunter, Apr. 8, 1863, *OR,* ser. 1, 14: 442. A monitor in Confederate hands would have tied up ironclads to guard against a sortie like that made by the far less capable *Palmetto State* and *Chicora.* Du Pont to James Stokes Biddle, Mar. 25, 1863, *Du Pont Letters,* 2: 510.

27. Welles, *Diary,* entry for Apr. 21, 1863, 1: 277. Welles to Du Pont, Jan. 31, 1863, *Du Pont Letters* 2: 399–400. James M. Merrill, *Du Pont: The Making of an Admi-*

ral (New York: Dodd, Mead, 1986), 298–99. Du Pont to Sophie Du Pont, Apr. 5, 1863, journal letter 51 (Apr. 5–6, 1863), *Du Pont Letters,* 2: 547.

28. Du Pont to Sophie Du Pont, Mar. 27, 1863, *Du Pont Letters,* 2: 518–19; Du Pont to John Rodgers, Mar. 25, 1863, *ORN* 13: 784.

29. Du Pont to Sophie Du Pont, Mar. 27, 1863, *Du Pont Letters,* 518–19. Du Pont opined that Stimers was "received like a dog in a tenpin alley by old Lincoln, Welles and Co. for thinking the monitors ought to be strengthened" (Du Pont to Henry Winter Davis, Apr. 1, 1863, ibid., 2: 534). Welles's outline agrees with Du Pont's deductions. Welles, *Diary,* entry for Mar. 12, 1863, 1: 247.

30. Welles, *Diary,* entry for Mar. 17, 1863, 1: 249. Du Pont to Charles Henry Davis, Jan. 4, 1863, *Du Pont Letters,* 2: 340. Circular of Instructions from the Commanding General, *ORN* 14: 102–3, and *OR,* ser. 1, 14: 733–35. Butler Diary, entry for Mar. 5, 1863.

31. Du Pont to Henry Winter Davis, Apr. 1, 1863, *Du Pont Letters,* 2: 534, and his letters to his wife during the week or two preceding the attack.

32. Rodgers probably mistook a shell splash for a torpedo explosion. The *Weehawken* would have had to strike a torpedo to set it off, and the *Montauk*'s experience shows that if she had, she would have been damaged. Confederate reports also emphasize that no ship came within 300 yards of the obstructions or of any torpedoes. This, however, is hindsight; in 1863 torpedoes were a high-tech unknown.

33. Rodgers and others considered the raft a waste; they refused to install the explosive charge because of the hazard to friendly ships. Rodgers to Du Pont, Apr. 20, 1863, *ORN* 14: 43–45, and Statement of Commanding Officers of Ironclads, Apr. 24, 1863, ibid., 45–48.

34. Abstract of ammunition expenditure, *ORN* 14: 27; Return of Ammunition Expended in Action and Return of Casualties in Action Appended to Report of Brigadier General Ripley, ibid., 84; Report of Casualties on the USS Keokuk and Report of Casualties on the USS Nahant, ibid., 4.

35. Report of Brigadier-General Ripley, *ORN* 14: 82; Report of Major Harris, ibid. 14: 85; Ripley to Jordan, Apr. 13, 1863, *OR,* ser. 1, 14: 259.

36. First report of Rear Admiral Du Pont, Apr. 8, 1863, *ORN* 14: 3. Lieutenant Henry B. Robeson to "My dear Aunt," Apr. 9, 1863, courtesy of Dr. Charles V. Peery. Du Pont to Welles, Apr. 16, 1863, *Report . . . Armored Vessels,* 78–80.

37. Du Pont to Welles, Apr. 22, 1863, *ORN* 14: 51–56. "Fulton came especially down to represent the monitor interest in full sympathy with Fox." Du Pont to Henry Winter Davis, May 3, 1863, *Du Pont Letters,* 3: 78. Fox denied it, *ORN* 14:64. "Newspaper clipping from the Baltimore American of April 15, 1863," in *ORN* 14:

57–59. Fox was allied by marriage with the Blair family, political enemies of Du Pont's close friend Henry Winter Davis.

38. Stimers to Welles, Apr. 14, 1863, in *Report . . . Armored Vessels,* 81.

39. Stimers to Fox, Apr. 19, 1863, Fox Papers, box 7.

40. Confederate gunners recognized this vulnerability and deliberately aimed for the turret bases. Circular of instructions, Dec. 26, 1862, *ORN* 14: 102–5.

41. Fox to Stimers, Apr. 25, 1863 (unofficial), Fox Papers, box 5A. Fox wrote Ericsson a similar letter. Fox to Ericsson, Apr. 24, 1863 (unofficial), ibid.

42. Fox to Stimers, May 27, 1863, Fox Papers, box 5A; Thomas J. Griffin to Stimers, July 9, 1863, NARG 19, entry 68, 1: 132; Stimers to Patrick Hughes, Sept. 20, 1863, NARG 19, entry 1252, 1: 306.

43. Stimers to Fox, Apr. 30, 1863, Fox Papers, box 7. A glacis was a stationary protective barrier attached *to the deck* to protect the junction between turret and deck.

44. Naval History Division, *Monitors,* 20; Canney, *Ironclads,* 79–80. Reinforcement did not fully solve the problem; e.g., Edward Simpson to Dahlgren, Sept. 10, 1863, *ORN* 14: 557. Some photographs that show this reinforcing ring incorrectly label it a glacis, but contemporary sources confirm that it was attached to the turret, not to the deck. Stimers to Secor & Co, June 18, 1863, encl. to Gregory to Lenthall, Jan. 9, 1864, NARG 19, entry 64, box 4, 19; NARG 19, Plan File, "Office General Plan of Tippecanoe Class"; Plan 1-9-34, "Forward Turret and Chamber for the U.S. Battery Onondaga"; Plan 1-10-28, "U.S. Monitor Montauk Inboard Profile."

45. Stimers to Secor & Co., June 18, 1863, in Gregory to Lenthall, Jan. 9, 1864, NARG 19, entry 64, box 4, 19. Dana Wegner, "The Port Royal Working Parties," *Civil War Times Illustrated* 15, no. 8 (Dec. 1976), 26–27, and Thomas J. Griffin to Stimers, July 9, 1863, NARG 19, entry 68, 1: 132. Before the *Catskill* was modified, the ready-for-action clearance between deck and turret ranged from 1/2 to 3 1/2 inches around the turret's circumference. William Gibson to Dahlgren, Dec. 30, 1863, in file "No. 1. Iron Clads Reports Aug 25 '63–Feb 1st '64," Dahlgren Papers.

46. Even with screens, casualties occurred. Report of Lieutenant Commander Charles C. Carpenter, Aug. 17, 1863, *ORN* 14: 458.

47. Du Pont to Major General David Hunter, Apr. 8, 1863, *ORN* 14: 30–31. Welles, *Diary,* entry for May 14, 1863; Welles to Du Pont, May 15, 1863, in *Report . . . Armored Vessels,* 96–97.

48. In mid 1862, Du Pont chided his wife for "oversevere" criticism of Fox, but a year later he called Fox an "upstart . . . swelled out like a toadfish," "an insect which lives for a single day," "a liar and a scoundrel." Du Pont to Sophie Du

Pont, June 30, 1862, *Du Pont Letters,* 2: 139; Du Pont to Sophie Du Pont, May 17, 1863, in journal letter 66, May 17–19, 1863, ibid., 3: 120; Du Pont to Henry Winter Davis, May 18, 1863, ibid., 3: 128; Du Pont to Percival Drayton, May 19, 1863, ibid., 3: 132.

49. Du Pont to Welles, 12 May 1863, *ORN* 14: 59–60.

50. Stimers to Fox, May 20, 1863, Fox Papers, box 7. Welles, *Diary,* entry for May 20, 1863, 1: 307.

51. Gregory to Fox, June 15, 1863, Fox Papers, box 6 (Gregory's emphasis). Stimers to Fox, June 14, 1863, ibid., box 7. The court record is in *Report . . . Armored Vessels,* 114–70.

Chapter 6. A Million of Dollars: The Price of "Continuous Improvement"

1. Asst. Inspector Thomas J. Griffin to Stimers, Feb. 29, 1864, NARG 19, entry 186, s.v. "Port Royal Working Party"; Wm. D. Andrews & Bro. to W. W. W. Wood, 11 Aug. 1864, ibid., s.v. "*Catawba.*"

2. Mindell, *War, Technology, and Experience,* 90.

3. Drayton to Welles, May 4, 1863, *ORN* 13: 174. Fox to Stimers, May 27, 1863, Fox Papers, box 5A.

4. Gregory to Du Pont, Apr. 6, 1863, NARG 19, entry 1235, 11: 21; Gregory to Fox, Apr. 6, 1863 (unofficial), Fox Papers, box 6; Delamater to Stimers, May 5, 1863, NARG 19, entry 186, s.v. "Port Royal Working Party." The "demoralized" deck layers were still in Port Royal in August. Reynolds to Dahlgren, Aug. 20, 1863, Reynolds Letterbook E-72, vol. 2.

5. Welles to Hughes, Apr. 18, 1863, NARG 45, entry M209, 71:58; Stimers to Hughes, June 1, 1863, NARG 19, entry 1252, 1: 130. Stimers to Fox, June 4, 1863, Fox Papers, box 7.

6. Wegner, "Port Royal Working Parties," 25–26; Stimers to Fox, June 4, 1863, Fox Papers, box 7; Gregory to Isaac Henderson, June 8, 1863, NARG 19, entry 1235, 11: 58. Stimers to Gregory, June 15, 1863, NARG 19, entry 186, Port Royal Working Party. Fox wanted the monitors strengthened as soon as possible. Fox to Stimers, June 3, 1863, Fox Papers, box 5A; Stimers to Fox, June 14, 1863, ibid., box 7.

7. Thomas J. Griffin to Stimers, June 25, 1863, NARG 19, entry 68, 1: 65; Stimers to Gregory, July 20, 1863, NARG 19, entry 64, vol. 3, pt. 2: 29; Griffin to Stimers, July 25, 1863, NARG 19, entry 68, 1: 204.

8. Fox to Stimers, June 3, 1863, Fox Papers, box 5A.

9. Du Pont to Henry Winter Davis, 3 May 1863, *Du Pont Letters,* 3: 75–79.

10. Dahlgren to Lincoln, Oct. 1, 1862; Welles to Dahlgren, Oct. 8, 1862, Dahlgren Papers.

11. Welles, *Diary,* entries for May 25, 27, 28, and 29, 1863, 1: 311–12, 314–15, 315–16, 317–18; entries for June 21 and 23, 1863, 1: 337–38, 341; Schneller, *Quest for Glory,* 243.

12. Dahlgren to Welles, July 22, 1863, *ORN* 14: 382; Dahlgren to Welles, July 23, 1863, ibid., 14: 388–89. Dahlgren to Welles, July 24, 1863, ibid., 14: 389–90. Dahlgren to Stimers, July 31, 1863, NARG 19, entry 186, s.v. "Port Royal Working Party."

13. Stimers to Gregory, July 20, 1863, NARG 19, entry 64, vol. 3, pt. 2: 29; Stimers to Fox, July 24, 1863, Fox Papers, box 7; Griffin to Stimers, July 25, 1863, NARG 19, entry 68, 1: 204. Reynolds to Dahlgren, Aug. 8, 1863, Reynolds Letterbook E-72, vol. 1.

14. Gregory to Stimers, Aug. 9, 1863, NARG 19, entry 1235, 12: 27; Gregory to Fox, Aug. 18, 1863, Fox Papers, box 6. Mara to Stimers, Sept. 23, 1863, NARG 19, entry 186, s.v. "*Sangamon*"; Hughes to Stimers, Oct. 2, 1863, ibid., s.v. "Port Royal Working Party." Reynolds to Dahlgren, Oct. 15 and 16, 1863, Reynolds Letterbook E-72, vol. 2.

15. Gregory to Lenthall, Nov. 22, 1863, enclosing Stimers to Gregory, Nov. 21, 1863, NARG 19, entry 64, vol. 3, pt. 3: 80. Stimers to Captain Young, commanding steamer *Commander,* Dec. 4, 1863, NARG 19, entry 1252, vol. 1; Reynolds to Dahlgren, Dec. 23, 1863, Reynolds Letterbook E-72, vol. 3.

16. Stimers to Lenthall, Sept. 7, 1863, NARG 19, entry 64, vol. 3, pt. 2: 84; Stimers to M. Mara, Sept. 10, 1863, NARG 19, entry 1252, 1: 310. Stimers to Fox, June 4, 1863, Fox Papers, box 7. Stimers to Fox, July 17, 1863, ibid.; Stimers to Fox, July 24, 1863, ibid. Ericsson to Fox, Apr. 23, 1862 (private typescript), Fox Papers, box 3.

17. *Annual Report of the Secretary of the Navy, 1860–61,* 16. Fox to Ericsson, Aug. 8, 1862, Fox Papers, box 3; Ericsson testimony, Light Draught Monitors, 68.

18. Fox to Stimers, Sept. 5, 1862, Fox Papers, box 5, mentions "the four foot boats." On September 17, Stimers reported that Ericsson had given up on an impregnable four-footer. Stimers to Fox, Sept. 17, 1862, ibid., box 4. Fox to Stimers, Sept. 20, 1862 (unofficial), Fox Papers, box 5.

19. Fox to Ericsson, Sept. 27, 1862, Ericsson Papers, reel 4. Fox's elaboration of such a comprehensive monitor "system" when monitors had had almost no combat experience bears out Andrew Gordon's analysis of how rationalist theory takes over when empirical experience is lacking. New technology, Gordon finds, assists in discrediting previous empirical doctrine, and the purveyors of the new technology will be the most evangelizing rationalists. Andrew Gordon, *The Rules of the Game: Jutland and British Naval Command* (Annapolis, Md.: Naval Institute Press, 1996), 579.

20. Stimers to Fox, Sept. 29, 1862, Fox Papers, box 4; Ericsson to Fox, Oct. 5, 1862, ibid., box 3.

21. Ericsson to Fox, Oct. 5, 1862, Fox Papers, box 3; Stimers to Fox, Oct. 8, 1862, ibid., box 4.

22. Stimers to Fox, Oct. 9, 1862, Fox Papers, box 4; Ericsson testimony, Light Draught Monitors, 68. Stimers to Fox, Nov. 10, 1862, Fox Papers, box 4; Stimers to Fox, Nov. 14, 1862, ibid.; Stimers to Fox, Nov. 20, 1862, ibid.

23. Stimers to Fox, Dec. 26, 1862, Fox Papers, box 4; Stimers testimony, Light Draught Monitors, 95–96. Stimers to Fox, Dec. 30, 1862, Fox Papers, box 4.

24. Stimers testimony, Light Draught Monitors, 97. Deposition of Theodore Allen, Aug. 11, 1873, NARG 123, entry 1, cases 6326/6327, Swift v. United States. Stimers calculated that each should cost $259,797.14 ready for sea. Stimers to Fox, Feb. 1, 1863, Fox Papers, box 7. The ships were advertised on Feb. 10, 1863. NARG 19, entry 405.

25. Stimers to Fox, Apr. 24, 1862, Fox Papers, box 4. Stimers later denied a request to change the sizes of plates and beams, writing, "There is a fitness of proportion in these matters." Endorsement on Globe Works to Stimers, June 27, 1863, NARG 19, entry 186, box 29, s.v. "*Suncook.*"

26. Mindell, *War, Technology, and Experience,* 31–40, 138–42.

27. Fox to Ericsson, Feb. 21, 1863 (unofficial), Fox Papers, box 5A. Ericsson to Welles, Feb. 24, 1863, NARG 45, entry M124, roll 435: 67.

28. Welles, *Diary,* entry for Aug. 2, 1865, 2: 349, 351.

29. The first two contracts went to Harlan & Hollingsworth, the only contractor to build three classes of monitors, and to Merrick & Son, successful builder of a non-monitor ironclad. Counting Merrick, seven of the first ten firms had ironclad-building experience. Fox was probably trying to stack the deck for quick construction.

30. Letterhead in use Sept. 1, 1863, NARG 19, entry 186, s.v. "*Koka.*" Levi T. Spencer to Stimers, May 13 and 27, 1863, NARG 19, entry 65, 2: 363, 420. They had built one 60-ton iron steamer in 1862. NARG 41, entry 138.

31. R. G. Dun, Maryland, 7: 146; 10: 162.

32. Joseph G. E. Larned to Stimers, May 13 and 27, 1863, NARG 19, entry 65, 2: 365, 421; R. G. Dun, New York, 132: 398.

33. Robert Robinson to Stimers, May 13, 1863, NARG 19, entry 64, 2: 358. Perine appears to have worked as a foreman for Secor & Co. until 1863. He was a shipbuilder in the 1850s but failed badly; in the 1860s, his credit was reported "weak." R. G. Dun, New York, 377: 62; 146: 107. Stimers to Gregory, Apr. 11, 1864, NARG 19, entry 64, vol. 5.

34. Eben Hoyt Jr. to Stimers, May 27, 1863, NARG 19, entry 65, 2: 413.

35. Seth Wilmarth to Stimers, July 8, 1863, NARG 19, entry 186, s.v. "*Nauset.*"

The contract for the *Nauset* was dated June 10, but that for the *Squando* dated from May 4, 1863.

36. Fox to Stimers, July 22, 1863, Fox Papers, box 5A. Naval History Division, *Monitors,* 25–27. Lawrence's contract was annulled, then reawarded when he promised to do the work in Portland (32 CtClms 248–49).

37. Fox to Stimers, Mar. 16, 1863, Fox Papers, box 5A. "Contract for Iron-Clad Steam Battery," 14 CtClms 208–35. Hackemer, *The U.S. Navy and the Origins of the Military-Industrial Complex,* 114–16.

38. Nathaniel McKay testimony, Light Draught Monitors, 31. 14 CtClms 215.

39. Ericsson to Welles, Feb. 25, 1863, NARG 45, entry M124, roll 435: 88.

40. Curtis & Tilden to Fox, Mar. 27, 1863, NARG 45, entry M124, roll 438: 90; Naval History Division, *Monitors,* 27. The ironwork was sublet to James Tetlow, a boilermaker, who built the vessel in Curtis & Tilden's shipyard. Andrew Lawton to Stimers, May 13, 1863, NARG 19, entry 64, 2: 360.

41. Deposition of Alban C. Stimers, Aug. 11, 18, 19, 1873, NARG 123, entry 1, cases 6326/6327, Swift v. United States.

42. Snowdon & Mason contracted for the light-draft *Umpqua* on March 9, 1863; Swift and Niles were awarded the *Klamath* and *Yuma* on March 26, 1863. For these contracts, the Charleston modifications were extra work. For later ships, "we require those who are now offering to build to take the new specifications at the same price or decline as they choose." Fox to Stimers, May 2, 1863 (unofficial), Fox Papers, box 5A.

43. Exhibit H, Evidence for Claimants, NARG 123, entry 1, Secor Cases, 152–55.

44. Deposition of Alban C. Stimers, Aug. 11, 18, 19, 1873, NARG 123, entry 1, cases 6326/6327, Swift v. United States. Stimers testimony in House Report (HRep) 766, 51st Cong., 1st sess., Mar. 10, 1890, 1. Stimers to contractors, Aug. 31, 1863, quoted in Report of Aaron H. Cragin and Isaac Newton, Special Commissioners appointed by the Court, NARG 123, entry 1, cases 6326/6327, Swift v. United States.

45. Kenneth P. Werrell, *Blankets of Fire: U. S. Bombers over Japan During World War II* (Washington, D.C.: Smithsonian Institution Press, 1996), 82, 72, 75, 80.

46. A shipyard did not start one Tippecanoe, launch her, and begin another—the whole class was under construction at once. In contrast, several but not all vessels of a World War II submarine class were under construction at any given time; e.g., Gato-class ships were ordered 1940 through 1942 and completed 1941 to 1944. John D. Alden, *The Fleet Submarine in the U.S. Navy: A Design and Construction History* (Annapolis, Md.: Naval Institute Press, 1979), app. 4.

47. Ibid., 78–79. The escort program operated similarly: after their shakedown cruises, ships built by contractors went to Navy yards for the latest alterations. Interview with William H. Roberts, M.D. (late lieutenant, U.S. Naval Reserve; first lieutenant, USS *Edgar G. Chase;* gunnery officer and executive officer, USS *Trumpeter*), Oct. 11, 1998. By contrast, constant changes hampered production during the World War I mobilization. Heinrich, *Ships for the Seven Seas,* 180–83, 185–89, 223.

48. The Polaris program took a third approach, one that emphasized a "planned series of system improvements." This "disciplined flexibility" reduced the pressures to make a given system perfect, "the kind of pressures which drive up program costs and lead to significant schedule slippages." Sapolsky, *Polaris System Development,* 250.

49. Software development provides a current example of the bad effects of "continuous improvement" on specialty items. Developers who succumb to the "urge to update" rather than "freezing" their designs may never deliver a workable system. I am indebted to Margaret J. Roberts of Ohio Legislative Information Systems for this insight.

50. Drayton to Du Pont, Oct. 1, 1862, *Du Pont Letters,* 2: 241.

51. Porter, "Delamater Iron Works," 13. Senator William P. Fessenden in *Congressional Record,* 37th Cong., 2d sess., Mar. 27, 1862, 1399–1400.

7. Progress Retarded: The Harbor and River Monitors, 1863–1864

1. Fox wanted a list, "as some of the parties I notice suggest to Stimers to get such authority from the Dept., which will be given as soon as we know what they are." Fox to Ericsson, Jan. 12, 1863, Fox Papers, box 5A.

2. Fox to Harrison Loring, Apr. 2, 1863, Fox Papers, box 5A; Fox to Ericsson, Apr. 6, 1863 (unofficial), ibid. Ericsson wrote that the items for which the contractors needed drawings were "very simple" but Fox wanted them "to work *your idea* not their own" (Fox's emphasis). Ericsson to Fox, Apr. 7, 1863, ibid., box 6; Fox to Ericsson, Apr. 9, 1863 (unofficial), ibid., box 5A. Secor & Co. to Fox, Apr. 14, 1863, NARG 45, entry M124, roll 440, 70.

3. Swift & Co. and the Niles Works, 14 CtClms 235–47, December Term 1878. Stimers to Gregory, Apr. 18, 1863, NARG 19, entry 64, 2: 286–87. The Navy's failure to pursue forfeitures, either during the war or after, strongly implies that the policy was accepted by the Navy's leadership.

4. Secor & Co. to Welles, June 17, 1863, NARG 19, entry 186, s.v. "*Tippecanoe.*"

5. Welles to Gregory, July 11, 1863, Welles Papers, Letterbook, May 23–Sept. 30, 1863, 233. Gregory to Stimers, Aug. 15, 1863, enclosing R. H. Long to Gregory,

Aug. 14, 1863, NARG 19, entry 64, 3: 67; Gregory to all contractors, Aug. 21, 1863, NARG 19, entry 1235, 12: 47.

6. Stimers to Fox, Sept. 30, 1863 (unofficial), Fox Papers, box 7.

7. Fox to Gregory, Oct. 9, 1863 (unofficial), Fox Papers, box 5A. The board was appointed October 16, 1863.

8. NARG 19, entry 362, Record of Payments on Contracts for Ships, 1861–1864. Stimers testified, "we investigated it—singly, and we made a good deal of red tape about it, and then we managed to pay for it in some way or other." Deposition of Alban C. Stimers, Aug. 11, 18, and 19, 1873, NARG 123, entry 1, cases 6326/6327, Swift v. United States.

9. Deposition of Alban C. Stimers, Aug. 11, 18, and 19, 1873, NARG 123, entry 1, cases 6326/6327, Swift v. United States. Deposition of Theodore Allen, July 25, 1877, ibid. Greenwood estimated for 105 alterations; the Navy returned only four. Claimant's statement of case, filed Feb. 26, 1875, ibid., case 7157, Greenwood v. United States.

10. Deposition of Alban C. Stimers, Aug. 11, 18, and 19, 1873, NARG 123, entry 1, cases 6326/6327, Swift v. United States. Thom testified, "There were several things left off [Secor ships] that were put on the others." Deposition of Nathaniel G. Thom, May 28, 1875, ibid. Thom mentions only Secor, but the first Secor vessel (the *Tecumseh*) was a contemporary of Harrison Loring's *Canonicus* and Harlan & Hollingsworth's *Saugus*.

11. Hill to Stimers, Nov. 10, 1863, NARG 19, entry 186, s.v. "*Catawba*"; Hill to Stimers, Jan. 1, 1864, ibid. Thom to Stimers, Jan. 14, 1864, ibid., s.v. "*Tippecanoe*."

12. J. W. King to Gregory, Oct. 5, 1863, NARG 19, entry 64, vol. 3, pt. 3: 35. Loring to Stimers, Nov. 10, 1863, NARG 19, entry 68, vol. 4, pt. 1 1863: 111. King to Fox, Feb. 4, 1864 (unofficial), Fox Papers, box 8.

13. Stimers to Fox, Feb. 1, 1863, Fox Papers, box 7. Stimers thought Whitney intended to push the forfeiture over $100,000, an amount "too enormous to exact." Contractors claimed to be losing money, but Stimers saw them enlarging their facilities; "I naturally conclude that such work is profitable." Stimers to Nelson Curtis, Feb. 29, 1864, Fox Papers, box 9.

14. Stimers to Secretary of the Navy George M. Robeson, Dec. 29, 1870, NARG 45, subject file AC.

15. Deposition of Charles A. Secor, Apr. 24, 1876, NARG 123, entry 1, case 7157, Greenwood v. United States; deposition of James F. Secor [Sr.] in evidence for claimants, ibid., case 29,943, Secor Cases. This was not the only time U.S. Navy officials threatened contractors. In 1862, Isherwood told machinery firms that if they refused Navy work, they would get no future contracts. If necessary, he said, "I would recommend what I had before suggested to the Department, to

take possession of the shops and have them operated exclusively for the Government work." Testimony of Benjamin F. Isherwood, Court of Claims Case 7169, Washington Iron-Works v. United States, in HRep 2789, 51st Cong., 1st sess.

16. Paul A. C. Koistinen, *Beating Plowshares into Swords: The Political Economy of American Warfare, 1606–1865* (Lawrence: University Press of Kansas, 1996), 178–83, 187, 265–69. Welles, *Diary*, entry for Feb. 3, 1863, 1: 232. Richardson, *Greatest Nation of the Earth*, 116–17, 121–23; Harlan & Hollingsworth, *1836 Semi-Centennial Memoir*, 117. Harrison Loring to Fox, Apr. 15, 1863, NARG 45, entry M124, roll 440: 94; John A. Griswold to Welles, Jan. 27, 1863, ibid., roll 432: 117, with endorsement.

17. Deposition of Alban C. Stimers, Aug. 25, 1873, NARG 123, entry 1, case 7157, Greenwood v. United States.

18. Gregory to Lenthall, July 14, 1865, NARG 19, entry 68, box 1: 2. The table appears as "Table A—Admiral Gregory's schedule of prices" in *Certain War Vessels,* SRep 1942, 57th Cong., 1st sess., 9–10.

19. Deposition of Nathaniel G. Thom, May 28, 1875, NARG 123, entry 1, cases 6326/6327, Swift v. United States. I have used a short ton of 2,000 pounds.

20. Deposition of Theodore Allen, July 25, 1877, NARG 123, entry 1, cases 6326/6327, Swift v. United States.

21. Harlan & Hollingsworth to Welles, Aug. 9, 1862, NARG 45, entry M124, roll 415: 262; emphasis original. Stimers to Gregory, Oct. 25, 1862, NARG 19, entry 65, 2: 159.

22. Western labor cost more, because, "this kind of labor was unusual in the west, and a man could not accomplish so much in a day." Thus, the cost for a given amount of work was greater west of the Alleghenies even if men earned the same wages as in the East. Stimers estimated that labor in the West cost some 50 percent more than on the eastern seaboard, and that overall costs (labor and materials) were about 25 percent greater. Deposition of Alban C. Stimers, Aug. 11, 18, and 19, 1873, NARG 123, entry 1, cases 6326/6327, Swift v. United States.

23. Charles Loring to Swift & Co., Aug. 22, 1865, in "Statement 38, Klamath & Yuma, Alex. Swift & Co., Cincinnati," NARG 19, entry 186, s.vv. "*Klamath*" and "*Yuma.*"

24. Unless otherwise noted, totals and graphs are based on interpolated values. The raw information is scattered in the reports of local inspectors in NARG 19, entries 64 and 68. Most do not cover machinery and boiler work, leaving those to the machinery inspectors.

25. Harlan & Hollingsworth took some 16,200 man-weeks to build the *Saugus* versus an average of some 11,600 man-weeks for each of the Secors' three ves-

sels. The firms paid comparable prices for labor and materials, and the vessels were practically identical, so Harlan & Hollingsworth's costs should have been dramatically higher. After the war, however, Harlan & Hollingsworth received only $38,513 extra for the *Saugus.* After receiving $69,550 extra for each of their three ships, the Secors continued to insist that they had lost money, claiming a total of over $500,000. 54 CtClms 97–99.

26. Some of the difference was undoubtedly actual savings from the "learning curve," but some probably came from improper cost accounting, i.e., charging labor that benefited both ships to the lead ship alone.

27. This counterintuitive result may reflect alterations made to later ships—the *Tecumseh* was commissioned in April 1864, the *Manhattan* in June, and the *Mahopac* in September 1864.

28. The last riverine ironclad built in Cincinnati, the *Tuscumbia,* was commissioned on March 12, 1863. From then on the monitors were the only warships under construction in the Queen City, but riverboat building and repairs to civilian and military vessels drew on some of the same labor pool.

29. Deposition of Alexander Jack, Oct. 5, 1891, NARG 123, entry 1, case 16,834, Snowdon v. United States. Deposition of Lewis T. Brown, Oct. 5, 1891, ibid. Deposition of Jacob Graser, Oct. 5, 1891, ibid.; deposition of Isaac Winn, Oct. 5, 1891, ibid. Winn recalled that the English contingent numbered thirty-five or forty men.

30. David Montgomery, *Beyond Equality: Labor and the Radical Republicans, 1862–1872* (New York: Knopf, 1967), 98, 103, 122; Iver Bernstein, *The New York City Draft Riots: Their Significance for American Society and Politics in the Age of the Civil War* (New York: Oxford University Press, 1990), 100, 103; Wilson K. Purse to Isherwood, Nov. 16, 1863, NARG 19, entry 975, 6: 99. Delays are specifically mentioned in "The Labor Movement. Probable Suspension of Work on the Iron-Clads" (clipping [n.p.], dated in pencil Nov. 11, 1863), in Dahlgren Papers, box 18.

31. Deposition of Nathaniel G. Thom, May 28, 1875, NARG 123, entry 1, cases 6326/6327, Swift v. United States. Strikes included boilermakers in April and riveters in September 1863, machine shop finishers in February, carpenters in March, and boilermakers in April 1864. All except the finishers (against Greenwood) affected Greenwood and Swift/Niles.

32. Harlan & Hollingsworth to Welles, Aug. 9, 1862, NARG 45, entry M124, roll 415: 262.

33. Ericsson to Fox, Aug. 9, 1862, Fox Papers, box 3. Bartol to Fox, Aug. 7, 1862, NARG 45, entry M124, roll 415: 200.

34. Swift to Welles, Aug. 15, 1862, NARG 45, entry M124, roll 416: 128. Welles to

Swift, Aug. 19, 1862, ibid., entry M209, 69: 191; Welles to Merrick & Sons, Aug. 19, 1862, ibid., 189; Welles to Harlan & Hollingsworth, Aug. 22, 1862, ibid., 207.

35. Greenwood to Fox, Oct. 7, 1862, NARG 45, entry M124, roll 421: 204, w/endorsement. Welles to Reaney, Son & Archbold, Oct. 18, 1862, NARG 45, entry M209, 69: 492; Welles to Reaney, Son & Archbold, Oct. 24, 1862, ibid., 70: 4. Niles Works to Fox, Dec. 2, 1862, NARG 45, entry M124, roll 427: 51, with endorsements. Snowdon & Mason also wanted discharges from the Army. Snowdon & Mason to Wells [*sic*], Jan. 15, 1863, NARG 45, entry M124, roll 431: 91.

36. Welles to Greenwood, Mar. 2, 1863, NARG 45, entry M209, 70: 452, and Apr. 18, 1863, ibid., 71: 58. Welles to Merrick & Sons, July 29, 1863, ibid., 577.

37. In August 1864, nearly 500 men left Reaney, Son & Archbold to enlist in the Navy or to move to avoid the draft. J. B. Houston to W. W. W. Wood, Aug. 18, 1864, NARG 19, entry 64, 7: 72. By contrast, Commodore J. W. Livingston's certificate averted conscription of a draftee who worked at the Mound City Naval Station machine shop. Livingston to Provost Marshal Captain C. D. Colman, Dec. 14, 1864, NARG 45, entry 452, Letters Sent by the Commandant of the Mound City Naval Station, 2: 52.

38. "Proclamation. Martial Law Declared." *Cincinnati Daily Commercial,* Sept. 2, 1862, 2.

39. Asst. Inspector Charles French to Stimers, July 20, 1863, NARG 19, entry 974, 5: 31–32; Charles Loring to Stimers, July 21, 1863, NARG 19, entry 68, box 2, vol. 1: 163. Loring to Stimers, May 10, 1864, ibid., 7: 102; deposition of Charles H. Loring, Mar. 22 and 25, 1876, NARG 123, entry 1, cases 6326/6327, Swift v. United States. Philadelphia-area shipbuilders felt similar disruptions during the Gettysburg campaign.

40. Charles Loring to Stimers, Jan. 19, 1864, NARG 19, entry 68, 6: 98. Seaboard shipbuilders' materials that came from inland could also be interrupted by severe weather.

41. "Tabulated Report of Ohio River," *ORN* 25: 610–11; *Report of the Commission . . . to select the most approved site for a navy yard or naval station on the Mississippi river or upon one of its tributaries,* Senate Executive Document (SExcDoc) 19, 38th Cong., 2d sess.

42. Porter to Welles, Feb. 16, 1864 (typescript marked "NWR 192:159"), NARG 45, subject file AD, box 48.

43. Charles French to Stimers, Apr. 12, 1864, NARG 19, entry 974, 7: 237.

44. "Another Ocean Monitor Afloat—Launching of the Iron Clad 'Catawba,' " *Cincinnati Daily Commercial,* Apr. 14, 1864, 1. Stimers to Gregory, Apr. 18, 1864, NARG 19, entry 68, 7: 225. It was a good week for Stimers; the *Canonicus* was commissioned on April 16 and the *Tecumseh* on April 19, 1864.

45. "Another Ocean Monitor," *Cincinnati Daily Commercial;* Charles Loring to Stimers, Apr. 26, 1864, NARG 19, entry 68, 7: 21.

46. Welles to Swift & Co., May 21, 1864, NARG 45, entry M209, 74: 150.

47. "The Launch of the Oneota," *Cincinnati Daily Commercial,* May 23, 1864, 2; Asst. Inspector Charles French to Stimers, May 24, 1864, NARG 19, entry 974, 8: 161. Charles Loring to Stimers, May 24, 1864, NARG 19, entry 68, 7: 164.

48. Towing the *Manayunk* cost $8,000, and "to keep it light" Snowdon & Mason shipped 400 tons of material "as ordinary freight." Deposition of Joseph S. Kirk, May 30, 1876, NARG 123, entry 1, cases 6326/6327, Swift v. United States.

49. Charles Loring to Stimers, June 7, 1864, NARG 19, entry 68, 7: 238.

50. Stimers to Greenwood, Jan. 9, 1864, NARG 19, entry 1252, 2: 58; Stimers to Snowdon & Mason, Apr. 1, 1864, ibid., 330. Charles Loring to Stimers, May 24, 1864, NARG 19, entry 68, 7: 164; Loring to Stimers, June 7, 1864, ibid., 7: 240; Loring to William W. W. Wood, July 19, 1864, ibid., 8: 155. King to Fox, July 20, 1864, Fox Papers, box 8. Naval History Division, *Monitors,* 22, n. 10. Snowdon & Mason's readiness is questionable; King wrote that they tried for a year to make a main engine cylinder for the *Manayunk* and finally had to order it from Niles Works.

51. Stimers to Fox, Oct. 9, 1862 (second letter), Fox Papers, box 4.

52. Deposition of Cornelius H. Delamater, July 30, 1877, Court of Claims 6327, Alexander Swift et al. v. United States, in NARG 19, entry 186, s.v. "*Catawba.*" Deposition of James F. Secor [Jr.], Aug. 23, 1909, NARG 123, entry 1, case 29,943, Secor Cases. Deposition of Oliver Perry Clark, July 25, 1877, ibid., cases 6326/6327, Swift v. United States.

53. Deposition of James F. Secor [Sr.], Aug. 8, 1873, NARG 123, entry 1, cases 6326/6327, Swift v. United States; deposition of Charles A. Secor, Apr. 24, 1876, ibid., case 7157, Greenwood v. United States. Secor & Co. to Welles, June 1, 1867, NARG 19, entry 186, box 22, s.v. "Claim of Secor & Company."

54. Deposition of Alexander Swift, Nov. 10–11, 1876, NARG 123, entry 1, case 7157, Greenwood v. United States. Pride would make it difficult for Harlan & Hollingsworth "to refuse to build one at the price we are paying others, though I am not certain they would take one so low." Stimers to Fox, Sept. 12, 1862, Fox Papers, box 4. Deposition of James F. Secor [Sr.], Aug. 8, 1873, ibid., cases 6326/6327, Swift v. United States.

55. For Merricks, R. G. Dun, Pennsylvania, 131: 233; 135: 320; for Swift, ibid., Ohio, 82: 71; 84: 41. For Niles, ibid., Ohio, 79: 271. For Greenwood, ibid., Ohio, 86: 98, 253; 87: 313. For Litherbury, ibid., Ohio, 81: 252. For Snowdon and Mason, ibid., Pennsylvania, 66: 576B, 47; 7: 199. In 1860, Fayette County (Brownsville) boasted three machinery firms, with capital totaling $119,000, and one ship-

and boatbuilder (probably Mason) with a capital of $2,000. U.S. Census Office, *Manufactures of the United States in 1860,* 508–9.

56. R. G. Dun, Delaware, 2: 38; Massachusetts, 70: 807.

57. They had also paid Joseph Colwell $50,000 to take over his establishment and avoid litigation. Deposition of James F. Secor [Sr.] in evidence for claimants, NARG 123, entry 1, case 29,943, Secor Cases; Secor & Co. to Welles, June 1, 1867, NARG 19, entry 186, s.v. "Claim of Secor & Company."

58. Stimers to Gregory, Feb. 4, 1864, NARG 19, entry 64, box 3 (Feb. 1864–May 1864), 6.

59. Hughes, *Networks of Power,* 19.

60. R. G. Dun, New York, 380: 8; Pennsylvania, 7: 199; Ohio, 79: 268, 271; 82: 71. Entries located for Greenwood begin in 1872.

61. Welles to George W. Quintard, June 27, 1863, NARG 45, entry M209, 71: 411.

62. NARG 19, entry 362, Record of Payments on Contracts for Ships, s.vv. "*Catawba*" (304–5), "*Oneota*" (322–23), and "*Tippecanoe*" (308–9). The payment depended upon progress; Swift received $38,333.33 each for the *Catawba* and the *Oneota* on October 4, 1864, but Greenwood did not receive the payment for the less complete *Tippecanoe* until May 26, 1865.

63. Greenwood to Gregory, July 7, 1864, NARG 19, entry 186, s.v. "*Tippecanoe.*" The implication that building monitors was *il*legitimate may reveal something of Greenwood's view of government business. Deposition of John N. Snowdon, Oct. 5, 1891, NARG 123, entry 1, case 16,834, Snowdon v. United States. Deposition of James F. Secor [Sr.] in evidence for claimants, ibid., case 29,943, Secor Cases.

64. Brown, *Baldwin Locomotive Works,* 25.

65. Stimers to Fox, Apr. 8, 1864, Fox Papers, box 9.

Chapter 8. The Sudden Destruction of Bright Hopes: The Downfall of the General Inspector

1. Chief Engineer King disparaged Snowdon & Mason, saying that the *Manayunk* "was more than a task for the parties who never did any other than the smallest business—giving them the second vessel has already delayed the work on the first." Even so, they were better than Tomlinson & Hartupee, who "cannot be taught even in the school of experience." King to Fox, Feb. 4, 1864 (unofficial), Fox Papers, box 8.

2. Draft of bill enclosed in Stimers to Fox, Feb. 18, 1864, Fox Papers, box 9.

3. Inspector Griffin, newly arrived in Port Royal, repaired the *Passaic* on station when it was feared she would have to be sent north to be fixed. LCDR E. Simpson to Dahlgren, Nov. 8, 1863, Naval Historical Center Operational Archives, ZB file, s.v. "Griffin, Thomas Jefferson" (box 95).

4. Fox to Ericsson, Dec. 30, 1862 (unofficial, typescript), Fox Papers, box 3.

5. Stimers to Fox, July 17, 1863, Fox Papers, box 7; Stimers to Fox, July 24, 1863, ibid.

6. In Apr. 1862, Stimers told Fox that Ericsson's plans for the Passaics were "so superior" that he gave up his own. By December, however, Stimers was insinuating that Ericsson's design was deficient and that his own would have been better; he accepted Ericsson's because Ericsson "took offense" and "would have done nothing if he had not been permitted to have had his own way." Stimers to Fox, Apr. 24, 1862, Fox Papers, box 4; Stimers to Fox, Dec. 21, 1862, ibid.

7. Sapolsky, *Polaris System Development,* 204, 250–51.

8. Stimers to Fox, Feb. 18, 1864, Fox Papers, box 9.

9. Stimers to Fox, Nov. 10, 1863, Fox Papers, box 7.

10. Gregory to Stimers, Oct. 28, 1863, NARG 19, entry 1235, 13: 25.

11. Gregory testimony, Light Draught Monitors, 73.

12. Gregory to Fox, June 15, 1863, Fox Papers, box 6. Gregory to Fox, Apr. 13, 1863 (unofficial), ibid.

13. Deposition of Alban C. Stimers, Aug. 11, 18, and 19, 1873, NARG 123, entry 1, cases 6326/6327, Swift v. United States. Representative correspondence in Fox Papers, all Stimers to Fox: Oct. 2, 1862, box 4; May 4, 1863, box 5A; July 17, 1863, box 7; Aug. 27, 1863, ibid.; Sept. 28, 1863, ibid.; Oct. 26, 1863, ibid. Gregory to Fox, Apr. 16, 1863 (unofficial), Fox Papers, box 6.

14. King to Fox, June 4, 1863, Fox Papers, box 7; Gregory to Fox, June 15, 1863, ibid., box 6; Gregory to King, June 26, 1863, NARG 19, entry 1235, 11: 66.

15. Gregory to Fox, June 27, 1863, Fox Papers, box 6. Gregory to King, July 3, 1863, NARG 19, entry 1235, 11: 69.

16. Gregory to Stimers, Oct. 28, 1863, NARG 19, entry 1235, 13: 25; Fox to Ericsson, Oct. 2, 1863 (unofficial), Fox Papers, box 5A. (Contrast this episode with the Polaris program's explicit efforts to enlist the support of line officers.) Stimers may have perceived his influence to be waning and proposed the Bureau of Iron Clad Steamers to formalize his position while he still could.

17. Stimers to Fox, May 17, 1863, Fox Papers, box 7. Fox to Stimers, June 3, 1863, Fox Papers, box 5A.

18. Stimers pointedly reminded one contractor that he, like most, had waited for Stimers's drawings rather than make his own. Stimers to Nelson Curtis, Feb. 29, 1864, in Stimers to Fox, Feb. 29, 1864, Fox Papers, box 9.

19. Luraghi, *History of the Confederate Navy,* 189–90.

20. Fox to Stimers, Feb. 25, 1864, Fox Papers, box 8.

21. Ibid.

22. Stimers to Fox, Feb. 29, 1864, Fox Papers, box 9 (Stimers's emphasis). Stim-

ers told Fox that Ericsson would blame the failure upon Stimers; he did. Ericsson to Fox, Feb. 27, 1864, ibid., box 8.

23. Stimers apparently instigated the assignment. Gregory testimony, Light Draught Monitors, 75. Deposition of Theodore Allen, Aug. 11, 1873, NARG 123, entry 1, cases 6326/6327, Swift v. United States. Stimers's letters are dated from New York; he apparently left Allen in Boston and visited frequently.

24. Fox to Ericsson, 22, 23, 24, and 28 Apr. 1864; Welles Papers, container 8, letterbook, Mar. 17–June 27, 1864, 109, 117, 119, 135. It is an example of Fox's enthusiasms, quickly developed, urgently pressed, and quickly fading.

25. Fox to Stimers, Apr. 23, 1864, Fox Papers, box 8; Stimers to Fox, May 2, 1864, ibid., box 9. Stimers had formally responded to the complaints. Wood et al. to Lenthall, Apr. 4, 1864, NARG 19, entry 64, 5: 26; Stimers to Gregory, Apr. 11, 1864, ibid. A circular letter of January 1864 told machinery inspectors, "It is impossible for the contractor to do more than comply [with the specifications]." NARG 19, entry 61, box 2.

26. Adams testimony, Light Draught Monitors, 12. Gregory to Welles, May 31, 1864, NARG 19, entry 1235, 24: 35–36.

27. Fox to Benjamin F. Wade, Dec. 15, 1864, in Light Draught Monitors, 3–5; Adams testimony, ibid., 12–13; Hanscom testimony, ibid., 5–6.

28. Stimers to Fox, May 31, 1864, Fox Papers, box 9.

29. Gregory testimony, Light Draught Monitors, 75–76; Fox to Gregory, June 3, 1864, Fox Papers, box 8; Ericsson to Fox, June 4, 1864, ibid. Fox to Gregory, June 15, 1864 (unofficial), Welles Papers, container 8, letterbook, Mar. 17–June 27, 1864, 271.

30. Stimers to Fox, June 8, 1864, confidential, from Boston, Fox Papers, box 9. Stimers would not have delayed in presenting his version to Fox, so it is likely that the meeting occurred on June 7.

31. Ibid.

32. Welles to Fox, June 10, 1864, Fox Papers, box 9. Fox faulted Stimers for completing the *Chimo* after launching "when he ought to have known that she was deficient in displacement." Fox to Gregory, June 15, 1864 (unofficial), Welles Papers, container 8, letterbook, Mar. 17–June 27, 1864, 271. After the *Chimo* was afloat, Stimers could have calculated her draft at completion; if he did, I find no record of it.

33. Stimers to Fox, June 16, 1864, Fox Papers, box 9. Stimers's reluctance to face the facts is understandable. Detachment for cause is professionally humiliating and personally shattering for a naval officer, and not everyone can maintain composure during the process.

34. Gregory to Fox, June 16, 1864, Fox Papers, box 8. Gregory to Wood, June 15,

1864, NARG 19, entry 1235, 20: 44; Gregory to Stimers, June 15, 1864, ibid.; Gregory to Stimers, June 17, 1864, ibid., 20: 45. Stimers's action was typical. He "keeps me as ignorant as he possibly can of his doings—considering himself as the supreme director and dictator in all matters," Gregory noted. Gregory to Lenthall, Apr. 12, 1864 (typescript), NARG 45, subject file AC.

35. If Schreiver's program had been low priority, "he could not have 'managed outside the system' no matter how great his powers of persuasion" (Hughes, *Rescuing Prometheus,* 104). See also Sapolsky, *Polaris System,* 42, 94–95.

36. Shipyard manpower on the *Klamath* and *Yuma* fluctuated between 340 and 450 men from November 1863 to July 1864; it bottomed at 22 in September and by mid November rose to 320. Stimers and Griffin were sent to Chester to strengthen the light-draft *Tunxis.* Ericsson's biographer Church writes that Stimers was "confronted" by a plate proclaiming that *Tunxis* had been built from Stimers's designs. "Mr. Stimers was evidently not proud of this record, for he was discovered at work one day with a cold chisel cutting his name out of the plate" (*Life of Ericsson,* 2: 30).

37. The "raft" should have been seasoned oak at 53 lbs/ft^3, but the available green oak weighed 64–70 lbs/ft^3. The iron ran 10 percent heavier than expected. Eben Hoyt testimony, Light Draught Monitors, 34–35, 39; Stimers testimony, ibid., 96–97. Nominal 1-inch plate averages 40 lbs/ft^2, with some plates a bit thicker and some a bit thinner. Stimers insisted that every plate meet the 1-inch minimum thickness, so thinner plates were rejected, driving up average thickness and weight.

38. Stimers testimony, Light Draught Monitors, 93, 103, 95.

39. Ericsson advised Fox before the contracts were let in March 1863 that he had had nothing to do with them, and Stimers referred possessively to "my plans" as late as February 1864. Ericsson to Welles, Feb. 24, 1863, NARG 45, entry M124, roll 435: 67; Stimers to Nelson Curtis, Atlantic Works, Boston, Feb. 29, 1864, Fox Papers, box 9.

40. E.g., Fox to Stimers, Jan. 15, 1863, Fox Papers, box 5A: "Can't you get some more civilians for inspectors and release a few Ch. Engineers? We are exhausted and must have some of them." The free flow of engineers into the inspectorate reversed after Stimers's fall from grace. In telling Stimers to send Griffin back to New York, Gregory noted, "So many of the Engineers & Inspectors have recently been detached, that he cannot be spared longer." Gregory to Stimers, Aug. 15, 1864, NARG 19, entry 1235, 20: 52.

41. Fox to Ericsson, Dec. 30, 1862 (unofficial, typescript), Fox Papers, box 3. Thirty years later, Isherwood noted with lingering resentment that Stimers had

been "absolutely untrammeled." Affidavit of B. F. Isherwood, Jan. 26, 1887, in HRep 766, 51st Cong., 1st sess., 5.

42. Welles, *Diary*, entry for Aug. 2, 1865, 2: 350–51. Sloan, *Benjamin Franklin Isherwood*, 77. Welles, *Diary*, entry for Aug. 2, 1865, 2: 349–51.

43. Charles Loring to Wood, Oct. 15, 1864, NARG 19, entry 186, s.v. "*Catawba*"; Loring to Wood, Oct. 27, 1864, ibid.

44. Charles Loring to Wood, Dec. 20 and 26, 1864, NARG 19, entry 186, s.v. "*Catawba*." Local Inspector William Alder to Wood, Jan. 31, 1865, NARG 19, entry 68, 10: 190.

45. Charles Loring to Wood, Mar. 2 and 10, 1865, NARG 19, entry 186, s.v. "*Catawba*"; Loring to Wood, Mar. 14, 1865, NARG 19, entry 68, 10: 70, 71. Loring to Wood, Mar. 14, 1865, NARG 19, entry 186, s.v. "*Tippecanoe*"; King to Welles via Gregory, Apr. 20, 1865, ibid.

46. Deposition of Captain R. Wilson Cowan, Oct. 5, 1891, NARG 123, entry 1, case 16,834, Snowdon v. United States (Cowan was engineer of *Panther*). Deposition of Joseph S. Kirk, May 30, 1876, ibid. (Cowan said $7,000, Kirk said $8,000.)

47. Livingston to Gregory, June 10, 1865, NARG 19, entry 186, s.v. "*Catawba*." Livingston to Wells, June 23, 1865, NARG 45, entry 452, Letters sent by Commandant of Mound City Naval Station, 2: 578; Edward A. Jenks to Livingston, July 10, 1865, NARG 45, entry 453, Letters Received by the Commandant of Mound City Naval Station, 3: 209.

48. Livingston to Gregory, Sept. 27, 1865, NARG 19, entry 186, s.v. "*Manayunk*."

49. Assistant Inspector Robert Gwynn to Wood, Apr. 26, 1865, NARG 19, entry 68, 11: 214; Gwynn to Wood, June 28, 1865, ibid., 11: 16.

50. *Cincinnati Daily Commercial*, Apr. 14, 1864; May 23, 1864; Dec. 23, 1864; May 31, 1865.

51. Charles French to Wood, Mar. 28, 1865, NARG 19, entry 68, 10: 114; French to Wood, May 28, 1865, ibid., 11: 244; William Alder to Chief Engineer Robert Danby, Aug. 27, 1865, ibid., 11: 81; Alder to Danby, Sept. 27, 1865, ibid., 11: 114. Alder to Danby, Oct. 27, 1865, ibid., 11: 144; Alder to Danby, Nov. 27, 1865, ibid., 11: 168. (Local inspectors' reports had been reduced to monthly.)

52. James F. Schenck to Gregory, Feb. 9, 1866, NARG 19, entry 186, s.v. "*Tippecanoe*"; Schenck to Gregory, Feb. 20, 1866, ibid.

Chapter 9. Good for Fifty Years: Winding Down the Mobilization

1. Harold and Margaret Sprout, *The Rise of American Naval Power* (Princeton: Princeton University Press, 1946), 165.

2. Reynolds to Dahlgren, May 17, 1864, NARG 45, entry 395, subentry E-72, vol. 5. Gregory to Charles Loring, Nov. 10, 1864, NARG 19, entry 1235, 21: 7; Wood to Loring, May 24, 1865, NARG 19, entry 1232, 3: 246.

3. Alden, *Fleet Submarine in the U.S. Navy,* 98–99; Norman Friedman, *U.S. Destroyers: An Illustrated Design History* (Annapolis, Md.: Naval Institute Press, 1982), 129–30, 152–53. Friedman notes that World War I saw no cancellations, and that the resulting glut of destroyers hobbled Navy shipbuilding for years (ibid., 46–48).

4. Fox to George B. Upton, June 12, 1863 (unofficial), Fox Papers, box 5A.

5. King to Welles via Gregory, Apr. 20, 1865, NARG 19, entry 186, s.v. "*Catawba.*" Ericsson to Church, Feb. 19, 1872, quoted in Church, *Life of Ericsson,* 2: 102. Michael E. Vlahos, "The Making of an American Style (1797–1887)," in *Naval Engineering and American Seapower, ed.* Randolph W. King (Baltimore: Nautical and Aviation Publishing, 1989), 19.

6. Gregory to Lenthall, Apr. 11, 1863, NARG 19, entry 1235, 11: 27.

7. Stimers to Gregory, Apr. 18, 1863, NARG 19, entry 64, 2: 285–87; Stimers to Gregory, May 4, 1863, NARG 19, entry 974, 3: 26.

8. Porter to Welles, Feb. 16, 1864, *ORN* 25: 756–61.

9. SExcDoc 19, 38th Cong., 2d sess.

10. Porter to Welles, Feb. 16, 1864, *ORN* 25: 758.

11. SExcDoc 19, 38th Cong., 2d sess., 14–17.

12. Welles to Cadwalader Ringgold, Oct. 26, 1866, in HMiscDoc 201, 42d Cong., 2d sess. Robert Danby to J. W. A. Nicholson, May 3, 1867, NARG 19, entry 64, vol. 13.

13. Du Pont to Fox, Oct. 24, 1862, *Du Pont Letters,* 2: 265–66, and note thereto.

14. Ericsson to Fox, Apr. 15, 1863, Fox Papers, box 6 (Ericsson's emphasis). One of Griffin's engineer friends asserted, "Give engineers full control of the Iron Clads . . . and our flag would soon wave from Sumter." Ida Dudley Dale, "Thomas Jefferson Griffin: Superintendent of Iron Clads," *Staten Island Historian* 11, no. 3, serial no. 43 (July–Sept. 1950): 19. Stimers to Fox, Apr. 19, 1863, Fox Papers, box 7.

15. Lance C. Buhl, "Mariners and Machines: Resistance to Technological Change in the American Navy, 1865–1869," in *Journal of American History,* 61 no. 3 (Dec. 1974), 709, 712, 717–19. Buhl notes the lack of professional credibility of naval engineers; some of that lack may stem from the perceived failures of the highly touted monitor program.

16. James F. Nagle, *A History of Government Contracting* (Washington, D.C.: George Washington University, 1992), 189–90, 198–211; Stuart D. Brandes, *Warhogs: A History of War Profits in America* (Lexington: University Press of Kentucky, 1997), 67–107.

17. Welles, *Diary,* entries for Jan. 25 and Feb. 12, 1867, 3: 28, 42.

18. Thom to Stimers, Feb. 5, 1864, NARG 19, entry 186, s.v. "*Tippecanoe.*" Greenwood's claim reached Gregory on May 23, 1864. Thom to [Stimers?], "Recd May 23d/64," ibid.

19. HMiscDoc 201, 42d Cong., 2d sess., 262.

20. "Relief for Contractors," *New York Times,* Feb. 14, 1865, 4 (emphasis in original).

21. *Congressional Globe,* 38th Cong., 2d sess., 98, 213, 1435; SExcDoc 18, 39th Cong., 1st sess.

22. SExcDoc 3, 40th Cong., 2d sess. SRep 163, 41st Cong., 2d sess., 2–3.

23. SRep 163, 41st Cong., 2d sess., 5. Deposition of Charles A. Secor, Apr. 24, 1876, NARG 123, entry 1, case 7157, Greenwood v. United States. Two senators had advised Secors that the act of 1868 would not bar their claims. HMiscDoc 201, 42d Cong., 2d sess., 350.

24. *Certain War Vessels,* SRep 1942, 57th Cong., 1st sess., 12. This payment engendered corruption charges against Robeson in 1872. HMiscDoc 201 and HRep 80 and 81, 42d Cong., 2d sess.

25. SRep 673, 44th Cong., 2d sess. Fox's threat to take over the Secors' shipyard if they stopped work tarnishes the luster of this statement, as does the cynic's view that unfinished ships were hardly "indispensable."

26. Stimers to Robeson, Dec. 29, 1870, NARG 45, subject file AC, box 23. SRep 163, 41st Cong., 2d sess., 5.

27. *Congressional Globe,* 39th Cong., 2d sess., 1134–35, 1785, 1952–53. HRep 269, 43d Cong., 1st sess. *Congressional Globe,* 40th Cong., 2d sess., 359.

28. HMiscDoc 201, 42d Cong., 2d sess., 262.

29. *Congressional Globe,* 39th Cong., 2d sess., app., 256.

30. Ibid., 40th Cong., 2d sess., 154–55, 209, 359–61.

31. Ibid., 816–17, 869, 937.

32. Ibid., 359; HRep 64, 40th Cong., 2d sess.

33. Welles, *Diary,* entry for May 8, 1868, 3: 348–49.

34. Livingston to Welles, June 17, 1865, NARG 45, entry 451, 1: 461.

35. Schenck to Welles, Mar. 27, 1866, NARG 45, entry 451, 2: 113; Schenck to Welles, Mar. 28, 1866, ibid., 2: 117.

36. Schenck to Lenthall, Apr. 9 and 11, 1866, NARG 45, entry 451, 2: 133 and 135; Lenthall to Schenck, Apr. 18, 1866, NARG 45, entry 453, 5: 71. Schenck to Lieutenant Commander Elias K. Owen, May 14, 1866, NARG 45, entry 452, 4: 183; Schenck to Welles, May 14 and June 2, 1866, NARG 45, entry 451, 2: 168 and 189.

37. Welles to Swift & Co., Aug. 19, 1867, NARG 45, entry M209, 80: 484, allowed Swift to take charge of the monitors but required surety for their return in good

condition if the sale were not completed. This corroborates that Welles initially thought the repurchase terms granted to Webb and Quintard would apply to others.

38. John D. Alden, "Monitors 'Round Cape Horn," *United States Naval Institute Proceedings* 100, no. 4 (Sept. 1974), 81–82. The two ships were scuttled in 1880.

39. Thomas C. Cochran, "Did the Civil War Retard Industrialization?" in *The Economic Impact of the American Civil War,* ed. Ralph Andreano, 2d ed. (Cambridge, Mass.: Schenkman Publishing, 1967), 167–79; Walter Licht, *Industrializing America: The Nineteenth Century* (Baltimore: Johns Hopkins University Press, 1995), 97–98. See Heinrich, *Ships for the Seven Seas,* 49–53, on the postwar shipbuilding slump.

40. NARG 41, entry 138.

41. F. Cyril James, *Cyclical Fluctuations in the Shipping and Shipbuilding Industries* (Ph.D. thesis, University of Pennsylvania, 1927), 41, 42. American builders faced high wages, low productivity, and high materials prices, elevated by a protective tariff on iron.

42. Heinrich, *Ships for the Seven Seas,* 41–42.

43. Buell, *Memoirs of Charles H. Cramp,* 72, 81.

44. Gail E. Farr and Brett F. Bostwick, *Shipbuilding at Cramp & Sons: A History and Guide to Collections of the William Cramp & Sons Ship and Engine Building Company (1830–1927) and the Cramp Shipbuilding Company (1941–46) of Philadelphia* (Philadelphia: Philadelphia Maritime Museum, 1991), 9–10, 53. R. G. Dun, Pennsylvania, 141: 70.

45. Deposition of Charles A. Secor, Apr. 24, 1876, NARG 123, entry 1, case 7157, Greenwood v. United States.

46. HMiscDoc 201, 42d Cong., 2d sess., 210.

47. HExcDoc 3, 40th Cong., 2d sess., 3.

48. R. G. Dun, Ohio, 79: 268, 71; 84: 41; 79: 271; 84: 154. For a glimpse of their convoluted financial dealings, see deposition of Gustavus Ricker, Jan. 5, 1877, NARG 123, entry 1, cases 6326/6327, Swift v. United States.

49. Swift's net worth grew from $150,000 in 1867 to $800,000 in 1872. R. G. Dun, Ohio, 82: 71; 84: 41.

50. R. G. Dun, Ohio, 79: 271; 84: 154. Goff took over Niles Tool Works, a division of Niles Works, in 1866. Rick Stager, *History of the Niles-Bement-Pond Tool Company* (Birchrunville, Pa.: N.p., 1993), 11.

51. Ricker testimony, HRep 64, 40th Cong., 2d sess., 86–130; Deposition of Gustavus Ricker, Jan. 5, 1877, NARG 123, entry 1, cases 6326/6327, Swift v. United States.

52. Deposition of John N. Snowdon, Oct. 5, 1891, NARG 123, entry 1, case 16,834, Snowdon v. United States; R. G. Dun, Pennsylvania, 66: 576B; 7: 199.

53. In the late 1860s, Ericsson designed and Delamater built thirty small gunboats for Spain, subcontracting the hulls. Porter, *Delamater Iron Works,* 12–14, 15–16, 17.

54. R. G. Dun, New York, 132: 419; "Ship-Building," *New York Tribune,* May 16, 1870, 4. After the war, Rowland built a 422-ton ship in 1866 and two 647-ton vessels in 1871; the next Continental hull was in 1885. NARG 41, entry 138.

55. Edwin L. Dunbaugh and William duBarry Thomas, *William H. Webb: Shipbuilder* (Glen Cove, N.Y.: Webb Institute of Naval Architecture, 1989), 117.

56. "Iron Works of New York," *New York Times,* Oct. 23, 1869, 3. Morgan and Quintard both built Navy machinery in the 1870s; Quintard's machinery was prominent in the "New Navy" of the 1880s and 1890s.

57. O'Har, "Shipbuilding, Markets, and Technological Change," 169 n.46; Bennett, *Steam Navy,* 914–15.

58. W. H. Bunting, *Portrait of a Port: Boston, 1852–1914* (Cambridge, Mass.: Harvard University Press, Belknap Press, 1971), 92. R. G. Dun, Massachusetts, 74: 131.

59. Donald McKay later built wooden gunboats in the Boston and Portsmouth Navy Yards. HMiscDoc 201, 42d Cong., 2d sess., 241; Donald L. Canney, *The Old Steam Navy,* vol. 1: *Frigates, Sloops and Gunboats, 1815–1885* (Annapolis, Md.: Naval Institute Press, 1990), 154–55; Bennett, *Steam Navy,* 647. R. G. Dun, Massachusetts, 73: 225, 228.

60. R. G. Dun, Pennsylvania, 135: 320. Southwark (formed in 1880) joined the Philadelphia machine works I. P. Morris and two other firms to form what became the Baldwin-Southwark division of the Baldwin Locomotive Works. *Baldwin-Southwark* 1 (Centenary Issue 1836–1936), no. 1: 7–8.

61. Leonard Alexander Swann Jr., *John Roach, Maritime Entrepreneur: The Years as Naval Contractor, 1862–1886* (Annapolis, Md.: Naval Institute Press, 1965), 51–53. R. G. Dun, Pennsylvania, 57: 382. Dun reports that Roach bought the works, which had cost $900,000, for $225,000.

62. Heinrich, *Ships for the Seven Seas,* 20, 27–28.

63. Canney, *Frigates, Sloops and Gunboats,* 156, 172; Tyler, *American Clyde* 27, 34, 112. Dun reports them in good credit, with a worth of $500,000, in 1867–74. R. G. Dun, Delaware, 2: 38. The firm built the iron gunboat *Ranger* in 1873 and gained many contracts for building the "New Navy" of the 1880s and 1890s.

64. Heinrich, *Ships for the Seven Seas,* 22; Charles H. Cramp, "Evolution of Screw Propulsion in the United States," *Transactions of the Society of Naval Architects and Marine Engineers* 17 (1909): 157–58.

65. Heinrich, *Ships for the Seven Seas,* 51; Swann, *John Roach,* 51.

66. Snowdon & Mason obtained a main steam cylinder from Niles Works and one of Charles Loring's letters indicates that Niles made gun carriages for Greenwood. Loring to Wood, Sept. 27, 1864, NARG 19, entry 68, 8: 193.

67. O'Har, "Shipbuilding, Markets, and Technological Change," 12.

68. Albert J. Churella, *From Steam to Diesel: Managerial Customs and Organizational Capabilities in the Twentieth-Century American Locomotive Industry* (Princeton: Princeton University Press, 1998), 7, 21, 61, 147. Brown sketched Baldwin's inability to transfer its expertise. Brown, *Baldwin Locomotive Works,* 228–33. Heinrich, *Ships for the Seven Seas,* 36–45, 51. Artisans and shipyards who built wooden vessels rarely acquired the skills and attitudes necessary to work in iron. O'Har, "Shipbuilding, Markets, and Technological Change," 12, 156–58, 160, 173–76.

69. O'Har, "Shipbuilding, Markets, and Technological Change," 160.

70. A parallel may be the transition from piston to jet aircraft engines. General Electric, with no piston experience, built jet engines successfully. The piston engine manufacturers Pratt & Whitney and Rolls Royce managed to make the transition, but others such as Napier and Curtiss-Wright failed to adapt.

71. Cist, *Sketches and Statistics,* 278–80. Dun describes him as "mfr. hardware &c" in 1872, and reports in 1878 that he had been in the hardware business for many years. R. G. Dun, Ohio, 86: 253; 87: 313.

72. R. G. Dun, Ohio, 86: 98, 253; 87: 313.

73. NARG 19, entry 362, 308–9, s.v. "*Tippecanoe.*"

74. J. W. Nicholson and Robert Danby to Lenthall, Apr. 30, 1867, NARG 19, entry 64, vol. 13 (1867): 23. SRep 1942, 57th Cong., 1st sess., 79; SExcDoc 3, 40th Cong., 2d sess., 3. SRep 422, 42d Cong., 3d Sess; Petition of Miles Greenwood, Apr. 10, 1873, NARG 123, entry 1, case 7157, Greenwood v. United States.

75. Deposition of Gustavus Ricker, Jan. 5, 1877, NARG 123, entry 1, cases 6326/6327, Swift v. United States. Ricker was "embarrassed"; he was a party to Alexander Swift & Co. but furnished no capital. HRep 64, 40th Cong., 2d sess., 86. Swift renewed its claim but its request was denied. Nicholson and Danby to Lenthall, Apr. 30, 1867, NARG 19, entry 64, vol. 13 (1867): 23.

76. SRep 1942, 57th Cong., 1st sess., 11, 49; SExcDoc 3, 40th Cong., 2d sess., 3. Swift's submission said "delays and change of plans" caused a loss of $342,908.14 on the two ships. NARG 19, entry 186, s.v. "*Catawba.*"

77. Deposition of Gustavus Ricker, Jan. 5, 1877, NARG 123, entry 1, cases 6326/6327, Swift v. United States. Charles Secor may have instigated the suits; in mid 1864, he agreed with Swift and Niles "to furnish the money and prosecute

these claims," and to pay Swift and Niles $30,000 if he realized that much after expenses. Secor later withdrew and assigned his interest back to Ricker.

78. Supplemental Argument of Defendants, filed Mar. 17, 1875, NARG 123, entry 1, case 7157, Greenwood v. United States; Brief for Defendants, filed Dec. 16, 1878, ibid. The government blamed *Tippecanoe*'s construction delays on the "slovenly, unprofessional, and unbusiness-like management of Mr. Thom" (ibid., 5). Greenwood must not have thought badly of Thom; he retained him for the entire project, at the high salary of $5,000 per year. Deposition of Nathaniel G. Thom, July 19 and Sept. 25, 1877, ibid.

79. Stimers resigned from the Navy in August 1865 rather than accept orders to sea duty. He died of smallpox on June 3, 1876, leaving a wife and five children. Durbrow, *The Monitor and Alban C. Stimers,* 19; Wegner, "Alban C. Stimers," 52–53.

80. Greenwood v. United States, 14 CtClms 597. Dun reported in 1879 that Greenwood had become "embarrassed through building Monitors for the Govt." R. G. Dun, Ohio, 87: 313.

81. 14 CtClms 208–35 (*Klamath* and *Yuma*), 235–47 (*Catawba* and *Oneota*). NARG 123, entry 1, cases 6326/6327, Swift v. United States. The receipt defense came from the case of the light-draft *Etlah.* The government could not use Greenwood's receipt as a defense because Congress had specifically referred Greenwood's case to the Court of Claims.

82. Private bills were reported out of committees in 1882 and 1886. 49th Cong., 1st sess., SRep 5, 1.

83. HRep 170, 45th Cong., 2d sess., 3. SRep 1942, 57th Cong., 1st sess.

84. HRep 452, 51st Cong., 1st sess.

85. SExcDoc 33, 41st Cong., 3d sess.

86. HRep 3397, 49th Cong., 1st sess.; HRep 766, 51st Cong., 1st sess.

87. Petition of John N. Snowdon, filed Oct. 21, 1890, NARG 123, entry 1, case 16,834, Snowdon v. United States. For arguments, the Petition (above), Claimant's Request for Findings filed Jan. 28, 1892, and Defendant's Brief and Defendant's Request for Findings filed Feb. 21, 1893, ibid. Awards to Snowdon are at 28 CtClms 563–64.

88. 53 CtClms 534–35, case 22,906.

89. SRep 1942, 57th Cong., 1st sess.; 54 CtClms 92–107.

Chapter 10. Additions, Alterations, and Improvements: Reversing Technological Momentum

1. Nagle, *History of Government Contracting,* 7.

2. Ibid., 181, 202.

3. Contractors had to post performance bonds, but the Navy does not seem to have invoked them. A similar bonding program for exporters was completely nullified by fraud. Ludwell H. Johnson, "Commerce Between Northern Ports and the Confederacy, 1861–1865," *Journal of American History* 54, no. 1 (June 1967), 31–34, 37, 41–42.

4. HMiscDoc 201, 42d Cong., 2d sess., 294–97, 306–11.

5. Isherwood noted the vital importance of clear specifications. HMiscDoc 201, 42d Cong., 2d sess., 294–97. The unstable environment of the war made fixed price contracts unsuitable even for such simple, well-defined items as clothing. *Annual Report of the Secretary of the Navy, 1862–63* (Washington, D.C.: GPO, 1863), 1033.

6. Nagle, *History of Government Contracting,* 181. The "turnaround" time for building locomotives was much shorter than for building ships, so the time lag in analyzing completed contracts was much shorter as well. Had the Navy procured ironclads sequentially, it might also have moved toward cost-plus contracts.

7. Ibid., 220.

8. Examples include the emergency shipbuilding programs in both world wars and the conversion of automobile manufacturers to airplane production in World War II. One key element was government financial support; another was the mass production nature of both. Unlike shipbuilders in peacetime or those who built complex combatants in wartime, the shipyards of the emergency programs were highly specialized.

9. In fairness, the prevailing view of relations between business and government might have made it impossible to tailor contracts to differing circumstances; certainly, the established contractors (and their political allies) would have complained bitterly if other firms had received startup aid that they had not been offered. However, there is no indication that Navy leaders seriously considered anything other than a "one size fits all" contract and much to suggest that tailored contracting did not occur to them.

10. Stimers to Gregory, Apr. 18, 1863, NARG 19, entry 64, 2: 285–87; Stimers to Gregory, May 4, 1863, NARG 19, entry 974, 3: 26. For quality, Porter to Welles, Feb. 16, 1864, NARG 45, subject file AD (typescript marked "NWR 192:159"); Henry A. Wise to Fox, Dec. 4, 1863, Fox Papers, box 7; Gregory to Lenthall, June 15, 1865, with enclosures, NARG 19, entry 64, box 6, vol. 9: 53; Gregory to Lenthall, Feb. 14, 1866, with enclosures, ibid., box 7, vol. 11: 51.

11. Ericsson to Fox, Mar. 19, 1862, Fox Papers, box 3.

12. Ten Passaics and the *Onondaga, Keokuk, Dictator,* and *Puritan* in private yards, plus four Miantonomohs in Navy yards.

13. Based upon Ericsson's recommendations, "the following parties on the Atlantic coast [are] capable of getting out the number opposite their names within four months." Stimers to Fox, Oct. 8, 1862, Fox Papers, box 4.

14. Stimers to Fox, May 17, 1863, Fox Papers, box 7. Fox to Stimers, June 3, 1863, ibid., box 5A. Four Kalamazoo-class ships were begun in Navy yards in mid 1863; four Miantonomohs had been under construction since 1862.

15. G. Pascal Zachary, "The Law of the Rathole," *Technology Review,* May-June 1999, 33.

16. By contrast, the ICBM program included duplication that, although costly, "assured that the failure of one contractor would not delay the project and insured a competitive search for solutions to front-edge research and development projects" (Hughes, *Rescuing Prometheus,* 109).

17. Welles, *Diary,* entry for June 10, 1864, 2: 52–53; entry for Feb. 21, 1865, 2: 241–42.

18. Stimers to Fox, June 16, 1864, Fox Papers, box 9.

19. Fox to Stimers, Feb. 25, 1864, Fox Papers, box 8.

20. Further investigation of the long-term effects on the supply of skilled labor is needed. The pool of ironworking labor was very small at the war's outset. The ironclad program gave on-the-job training to thousands of workers, who found few jobs in shipbuilding after the war but who would have been unlikely to return to less skilled and less well paid labor if they could help it. John Roach noted, for example, that he had hired shad fishermen and farmhands to work in his shipyard in the 1870s, and that after eighteen months training, his workers would "never fish for shad again" (Swann, *John Roach,* 61). The availability of a pool of skilled ironworkers almost certainly facilitated other construction in iron.

21. *Conway's All the World's Fighting Ships, 1860–1905,* ed. Robert Gardiner (London: Conway Maritime Press; New York: Mayflower Books, Naval Institute Press, 1979), 126–29. Canney, *Frigates, Sloops and Gunboats,* 145–66, 172.

22. Hackemer, "Building the Military-Industrial Relationship," 100–107.

23. Swann, *John Roach,* chs. 7–10, discusses the "New Navy" ABCD ships. Roach had also "rebuilt" several monitors in a way that amounted to jacking up the old ship's name and building a new ship under it. Benjamin Franklin Cooling, *Gray Steel and Blue Water Navy: The Formative Years of America's Military-Industrial Complex, 1881–1917* (Hamden, Conn.: Archon Books, 1979), 36–39, 50–51, 57–58; Hackemer, "Building the Military-Industrial Relationship," 105–7.

24. Hughes, *Networks of Power,* 286.

25. Hughes, *Rescuing Prometheus,* 144.

26. The Navy's slowness to field unmanned aerial vehicles in the 1970s and 1980s may have been due in part to a similar reaction against the DASH (Drone Anti-Submarine Helicopter) program. DASH flights had a not entirely undeserved reputation for untoward endings: operators perceived that their craft would either ignore signals and disappear over the horizon, or crash while landing aboard ship. Despite the desirability of giving small combatants an aviation capability, DASH failed to gain a constituency among surface warfare officers to offset the aviation community's opposition to pilotless aircraft.

27. Sapolsky, *Polaris System Development,* 61.

28. Fox to Ericsson, Feb. 28, 1863, Fox Papers, box 5A.

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Essay on Sources

WHILE there is a mountain of literature on the Civil War and a foothill on the naval war, a large fraction of the naval works are operationally oriented. A good-sized body of literature of varying quality deals with the ships themselves, and a smaller number of authors have written on the strategic and political aspects of the naval struggle and on naval administration. Very little work has been done on the acquisition and logistics systems that provided the Navy with ships and kept them at sea, and no studies exist on the industrial effort spawned by the Navy's urgent need for ironclads. To examine the subject of naval industrial mobilization, one must approach its literature from several aspects; at a minimum, naval, biographical, industrial, and technological.

The *Monitor* herself has fascinated writers since the Battle of Hampton Roads in 1862. The "monitor myth" tells how the brilliant inventor John Ericsson persuaded mossbacked naval officers to try his revolutionary armored warship. After a Herculean effort, his *Monitor* ventured forth to battle, miraculously surviving a gale on her way. Arriving in the nick of time, the "heroic little cheesebox on a raft" met the Confederate behemoth *Merrimack* in a seagoing version of David and Goliath, with the Union at stake. In a happy ending, the Navy forsook its earlier skepticism, built a fleet of Monitors and won the war with them. A more accurate account, less frequently encountered, is no less interesting. Worthwhile examinations of the ship's inception and construction include William N. Still's *Monitor Builders: A Historical Study of the Principal Firms and Individuals Involved in the Construction of USS Monitor* (Washington, D.C.: National Park Service, 1988) and Stephen C. Thompson's thesis and article, "The Design and Construction of USS *Monitor*" (*Warship International* 27, no. 3 [1990]). A more culturally oriented discussion of the vessel and her context is David A. Mindell's *War, Technology, and Experience aboard the USS Monitor* (Baltimore: Johns Hopkins University Press, 2000).

Many published works briefly address the later monitor-building program in a few sentences or paragraphs. Such books almost always mention the "light

draft monitor fiasco," generally assigning the role of goat to Stimers, with more or less attention to the parts played by Fox, Ericsson and the bureau chiefs. Excepting Donald L. Canney's recent *Lincoln's Navy: The Ships, Men and Organization, 1861–65* (Annapolis, Md.: Naval Institute Press, 1998), which gives a glimpse of the process by which ships were produced, nothing has been written about naval industrial mobilization. The impact of such innovations as centralized configuration control, integrated logistics support, and "project office" organization has not been explored, nor have the ways in which economic and industrial conditions affected the Navy's ironclad building.

Naval logistics have been similarly neglected. Robert M. Browning Jr.'s *From Cape Charles to Cape Fear: The North Atlantic Blockading Squadron during the Civil War* (Tuscaloosa: University of Alabama Press, 1993) is among the few published works to examine naval logistics, but Browning's very valuable work stresses operational logistics rather than acquisition. A shorter, more narrowly focused study of ironclad logistics matters is Dana M. Wegner's article on the Port Royal Working Parties ("The Port Royal Working Parties," *Civil War Times Illustrated* 15, no. 8 [December 1976]).

Of the major players in the Navy's industrial mobilization, Secretary of the Navy Gideon Welles has received the most attention. The "standard" biography is John Niven's 1973 *Gideon Welles: Lincoln's Secretary of the Navy* (New York: Oxford University Press, 1973); among older works is Richard S. West Jr.'s *Gideon Welles: Lincoln's Navy Department* (Indianapolis: Bobbs-Merrill, 1943). Both books understandably focus more on the secretary himself and upon the politics and strategy of the war than on the mobilization effort. William J. Sullivan's "Gustavus Vasa Fox and Naval Administration" (Ph.D. diss., Catholic University of America, 1977) on Gustavus Fox's administration of the Navy Department is the only lengthy work on this complex figure. Sullivan brings out much of the friction that affected the construction program, but some of his conclusions are questionable. John D. Hayes's article, "Captain Fox—*He* Is the Navy Department" (*United States Naval Institute Proceedings* 91, no. 9 [September 1965]) ably sets out the views of the "Fox as Chief of Naval Operations" school, but its discussion of monitor procurement contains missteps.

Among lower-ranking figures, Engineer-in-Chief Benjamin Franklin Isherwood is the subject of a well-regarded biography by Edward William Sloan III: *Benjamin Franklin Isherwood, Naval Engineer: The Years as Engineer in Chief, 1861–1869* (Annapolis, Md.: Naval Institute Press, 1965). The only work on Stimers is Dana M. Wegner's "Alban C. Stimers and the Office of the General Inspector of Ironclads, 1862–1864" (M.A. thesis, State University of New York College at Oneonta, 1979). Biographies of Cincinnati's monitor builders are limited to

nineteenth-century vanity press articles (e.g., Greenwood) or obituaries (e.g., Swift), and eastern builders are equally poorly represented.

The dissertations of Barbara B. Tomblin, Aubrey H. Polser, and Kurt H. Hackemer are key studies in the limited literature on naval procurement and administration. Tomblin's "From Sail to Steam: The Development of Steam Technology in the United States Navy, 1838–1865" (Ph.D. diss., Rutgers, 1988), dealing with the pre–Civil War relationship between the Navy and civilian ship and engine builders, demonstrates that the Navy was aware of technological developments and kept itself informed of the capabilities of the country's engineering establishments. Her treatment of naval building, however, lumps together the building of steam-propelled wooden ships (by the 1860s a maturing technology) and ironclads (still largely experimental). Her analysis of the Navy's industrial expansion is sometimes simplistic; for example, while drawings and specifications were "readily available," drawings alone did not guarantee success.

Polser's "The Administration of the United States Navy, 1861–1865" (Ph.D. diss., University of Nebraska, Lincoln, 1975), although generally sound, paints ship procurement with a broad brush. He recognizes that lack of timeliness and cost overruns were the most persistent difficulties but does not delve into their causes. Polser correctly sees "the frequent necessity to alter ship specifications" as a problem, but he blames Stimers for "interference" and characterizes the intervention of "top naval administrators" as "improper." Viewing the General Inspectorate purely as a quality-control organization, he fails to observe its internal dynamics or to see how and why it evolved into the monitor project office. His observations on contracts similarly lack context; many contractual elements that he asserts were "devised" for war-built ships were either held over from prewar practice or were clauses required by law, and contracting practice evolved during the war. Polser's assertion that the Navy provided drawings piecemeal to maintain "the privacy and the secrecy of its contracts" is incorrect. Stimers well understood the urgency—he sent each plan as soon as it was finished, and if his draftsmen could have produced plans faster, he would have sent them sooner. The contractors held identical contracts and received identical drawings, so withholding plans could have no effect whatever on their "financial privacy."

Hackemer's "From Peace to War: U.S. Naval Procurement, Private Enterprise and the Integration of New Technology, 1850–1865" (Ph.D. diss., Texas A&M University, 1994), a study of Navy contracting practices, is extremely valuable for its examination of the acquisition system that the Navy evolved in the 1850s and its assessment of that system's performance under the stress of war in the 1860s. His case study comparison of the *Merrimack*, built under the 1850s sys-

tem during peacetime, and the *Galena,* built under the same system under wartime pressures, provides many insights into the evolving relationship between the Navy and its shipbuilders. His *The U.S. Navy and the Origins of the Military-Industrial Complex, 1847–1883* (Annapolis, Md.: Naval Institute Press, 2001) expands upon this subject.

The broad question of whether the Civil War advanced or retarded industrialization can be answered in the negative in the area of iron shipbuilding. Cincinnati's experience (and those of Pittsburgh, New York, and Boston as well) supports Walter Licht's thesis in *Industrializing America: The Nineteenth Century* (Baltimore: Johns Hopkins University Press, 1995) that the war's direct economic effects were limited; when the federal government "receded," so did shipbuilding. Paul A. C. Koistinen's *Beating Plowshares into Swords: The Political Economy of American Warfare, 1606–1865* (Lawrence: University Press of Kansas, 1996) argues that the key element in Civil War mobilization was the preponderance of resources over requirements—that the mobilized manpower and industrial capacity of the United States exceeded the demands of the war. The Union could thus use financial incentives to mobilize without creating a "command economy" and without seriously disrupting normal civil-military relations. This was true of the Army, which absorbed the largest share of the men and money poured into the war, and it was broadly true of the much smaller Navy too. The labor and materials shortages that crippled the monitor program show, however, that the characterization of sufficiency must be qualified in several areas crucial to the success of naval industrial mobilization. Mobilization by financial incentive was not uniformly successful.

Thomas R. Heinrich's *Ships for the Seven Seas: Philadelphia Shipbuilding in the Age of Industrial Capitalism* (Baltimore: Johns Hopkins University Press, 1997) addresses the transition in the shipbuilding industry from building in wood to building in iron and helps to narrow the focus from industrialization in general to shipbuilding in particular. While his work deals specifically with Delaware Valley shipbuilders and predominantly with the post–Civil War period, his analysis is applicable to both the Civil War expansion and the postwar contraction of western yards. George Michael O'Har's "Shipbuilding, Markets, and Technological Change in East Boston" (Ph.D. thesis, Massachusetts Institute of Technology, 1994) provides a useful view of technological change focused on the experiences of shipyard workers. As yet, there is no generalized study of the wood-to-iron transition in shipbuilding.

Another useful lens through which to examine the naval mobilization is that of the specialty industrial producer. Philip Scranton's *Endless Novelty: Specialty Production and American Industrialization, 1865–1925* (Princeton: Princeton Uni-

versity Press, 1997) provides a taxonomy of specialty production that helps both to characterize western shipbuilders and to correlate their relative success with their ability and experience as custom producers. Scranton's assertion that Civil War production "solidif[ied] shipbuilders' technological shift to iron vessels" seems, however, to run counter both to Heinrich's assessment and to the experience developed in this work.

John K. Brown's *The Baldwin Locomotive Works, 1831–1915: A Study in American Industrial Practice* (Baltimore: Johns Hopkins University Press, 1995) specifically addresses the specialty production of capital equipment, but much in his work is directly applicable to shipbuilders. Most illuminating is his discussion of how Baldwin, a specialty producer, turned the inflationary Civil War environment to its advantage. Baldwin's success may be contrasted with the experiences of the shipbuilders. Like the monitors, locomotives were complex mechanisms, custom-built to order. Relative to ironclads, however, they were quick to build, and Baldwin had much more capital relative to the price of its product than did the shipbuilders. The combination of shorter-term contracts and higher capitalization permitted Baldwin to use the flexibility that Brown and Scranton call the hallmark of the specialty producer. Shipbuilders, locked into long-term fixed-price contracts that absorbed most of their capital, lost that flexibility. More recently, in his "Design Plans, Working Drawings, National Styles: Engineering Practice in Great Britain and the United States, 1775–1945" (*Technology and Culture* 41, no. 2 [April 2000]), Brown examines the subject of engineering drawing and plans; his analysis of the "deskilling" impact of detailed production drawings illuminates Stimers's decision to provide detailed plans to help unskilled builders.

It is well to recall that ironclads formed part of a sociotechnical system and that the new technology was advanced by human beings, each of whom brought baggage in the form of existing ideas, attitudes, and social and bureaucratic position. Such individuals and their organizations evolve and change along with the technology they apply. Merritt Roe Smith's perceptions of "the centrality of management to military enterprise" and of war as a period of "rapid growth and increased competition" are clearly borne out in the results of the monitor program. The concepts put forth by Thomas P. Hughes in *Networks of Power: Electrification in Western Society, 1880–1930* (Baltimore: Johns Hopkins University Press, 1983), and *Rescuing Prometheus* (New York: Pantheon Books, 1998), including the "reverse salient," are directly applicable to the Union naval mobilization. Most of Hughes's work, however, involves projects that were perceived as successful: ICBM development, the SAGE program, and electrification. His formulation of technological momentum may be extended if

one considers that momentum is a vector quantity, possessing direction as well as magnitude. Technological momentum will be affected differently by failure than by success, and the failure of the monitor program changed the Navy's technical and managerial momentum for a generation. A recent counterexample, of a large and successful Navy program, is the Polaris Fleet Ballistic Missile System development analyzed by Harvey M. Sapolsky's *The Polaris System Development: Bureaucratic and Programmatic Success in Government* (Cambridge, Mass.: Harvard University Press, 1972).

No investigation of industrial firms would be complete without a review of the R. G. Dun & Co. collection of credit records, which gives a revealing look at shipbuilders' financial ups and downs. The complex relationships among Stimers, Fox, and Ericsson are reflected in the papers of the latter two; unfortunately, Stimers's personal papers have not survived, and Ericsson destroyed most of his. The American Swedish Historical Foundation has issued a reasonably complete microfilm edition of Ericsson's surviving papers (Philadelphia, Pa.: Historic Publications, 1970). Serious research on Fox requires consulting his papers at the New-York Historical Society; the only published Fox collection, *Confidential Correspondence of Gustavus Vasa Fox, Assistant Secretary of the Navy, 1861–1865,* ed. Robert Means Thompson and Richard Wainwright (2 vols., 1918–19; reprint, Freeport, N.Y.: Books for Libraries Press), is extremely limited and incomplete. The papers and diary of Gideon Welles are likewise essential (and more readily available), but because Welles delegated responsibility for ironclad procurement to Fox, the secretary's papers give the "big picture" rather than more detailed views. The extensive published correspondence of Samuel Francis Du Pont provides a candid and frequently unflattering view of the monitors that helps to balance Fox's enthusiasm. For this, see *Samuel Francis Du Pont: A Selection from His Civil War Letters,* vol. 1: *The Mission: 1860–1862;* vol. 2: *The Blockade: 1862–1863;* vol. 3: *The Repulse: 1863–1865,* ed. John D. Hayes (Ithaca, N.Y.: Cornell University Press for the Eleutherian Mills Historical Library, 1969).

Important holdings of the National Archives in Washington, D.C., include the Bureau of Ships records in Record Group (RG) 19, the Navy Department records in RG 45, and the Bureau of Yards and Docks records in RG 71. Shipbuilders' postwar claims against the government led to protracted litigation that is reflected in RG 123, Records of the Court of Claims; this exceptionally valuable, voluminous, and underutilized material includes depositions and documents from both industry and government sources.

Significant government documents include numerous reports to Congress on postwar claims: the wartime *Report of the Secretary of the Navy in Relation*

to Armored Vessels, House Executive Document 69, 38th Cong., 1st sess., 1864, and the *Report of the Joint Committee on the Conduct of the War, Thirty-eighth Cong.*, 2d sess. (Washington, D.C.: GPO, 1865), "Light Draught Monitors." Although they are operationally oriented, some insights on mobilization and management may be gained from the *Official Records of the Union and Confederate Navies in the War of the Rebellion* (Washington, D.C.: GPO, 1894–1922).

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